

describe success reaction modern things

MICROCOPY RESOLUTION TEST CHART NATIONAL BUREAU-OF STANDARDS-1963-A





S. A. Stepanek

Calspan Field Services, Inc.

September 1983

Final Report for Period 27 May to 11 August 1983

Approved for public release; distribution unlimited.

UTE FILE COPY

ARNOLD ENGINEERING DEVELOPMENT CENTER
ARNOLD AIR FORCE STATION, TENNESSEE
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

84 04 19 108

NOTICES

When U. S. Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, or in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

References to named commercial products in this report are not to be considered in any sense as an endorsement of the product by the United States Air Force or the Government.

APPROVAL STATEMENT

This report has been reviewed and approved.

J. T. BEST

.J. Best

Aeronautical Systems Branch Deputy for Operations

Approved for publication:

FOR THE COMMANDER

JOHN M. RAMPY, Director

Aerospace Flight Dynamics Test

Deputy for Operations

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER AEDC-TSR-83-V29	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) AEROTHERMAL WIND TUNNEL TEST OF THE SPACE SHUTTLE OMS POD AFRSI MATERIAL		5. TYPE OF REPORT & PERIOD COVERED Final Report for May 27 to August 11, 1983	
		6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(e)		8. CONTRACT OR GRANT NUMBER(s)	
S. A. Stepanek, Calspan Field Serv	vices, Inc.		
9. PERFORMING ORGANIZATION NAME AND ADDRE Arnold Engineering Development Cer Air Force Systems Command Arnold Air Force Station, TN 3738	nter/DO	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Element 921E01 Control No. 9E01	
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE September 1983	
NASA/JSC Houston, TX 77058		13. NUMBER OF PAGES 70	
14. MONITORING AGENCY NAME & ADDRESS(If dillerent from Controlling Office)		15. SECURITY CLASS. (of this report) Uclassified	
	·	154. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available in Defense Technical Information Center (DTIC).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AFRSI aeroheating OMS Pod space shuttle

materials testing wind tunnel testing

heat transfer

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Wind tunnel tests on Advanced Flexible Reusable Surface Insulation (AFRSI) used to protect the Orbital Maneuvering System (OMS) Pod of the Space Shuttle Orbiter were performed in the von Karman Gas Dynamics Facility Aerothermal Wind Tunnel (C). A wedge was used to subject the AFRSI to the desired local flow conditions in a free stream Mach 4 flow with the objective of duplicating the AFRSI material failure that occurred during the STS-6 flight. Selected results are presented to illustrate the test techniques and typical data obtained.

DD 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Q

CONTENTS

松林 医沙

Ì.

		Page
	NOMENCLATURE	3
1.0	· · · · · · · · · · · · · · · · · · ·	6
2.0		•
_••	2.1 Test Facility	6
	2.2 Test Article	7
	2.3 Test Instrumentation	
3.0	TEST DESCRIPTION	
•••	3.1 Test Conditions	10
	3.2 Test Procedures	10
	3.3 Data Reduction	12
	3.4 Uncertainty of Measurements	15
4.0	DATA PACKAGE PRESENTATION	16
	REFERENCES	17
	APPENDIXES	
ı.	ILLUSTRATIONS	
Figu	<u>ire</u>	
1.	Tunnel C - Aerothermal Mach 4 Configuration	19
2.	Installation of Test Article - Feasibility Checkout Entry	20
3.	Feasibility Test Article in Tunnel Tank	22
4.	Aerotherm Wedge - Feasibility Checkout Entry	23
5.	Feasibility Test Models	24
6.	Installation of Test Article - Calibration and Material	
	Evaluation Entry	25
7.	Test Article - Calibration and Material Evaluation Entry	27
8.	Contour of OMS Pod Test Models	29
9.	Pressure Calibration Test Article	30
10.	Thermal Calibration Test Article	32
11.	Typical AFRSI Test Sample	34
12.	Tunnel-Exposed Test Articles	35
13.	Typical Oil-Flow Visualization Data	39
14.	Spatial Correlation of Digitized IR Data with Camera Field of	
	View and Test Article	40
II.	TABLES	
1.	Gardon Heat Gage Locations	42
2.	Static Pressure Tap Locations	43
-3.	Kulite Dynamic Pressure Gage Locations	45
4.	Coordinates of 0.2-Scale Partial OMS Pod Contour	46
5.	Thermal Model Surface Thermocouple Locations	47
·· 6.	AFRSI Sample Descriptions	47
7.	Estimated Uncertainties	48
8.	Photographic Data Summary	51
9.	Test Summary	52
		1

		Pag	e
10.	Summary of Data Acquisition and Tabular Print	• 5	5
111.	SAMPLE TABULATED DATA		
1.	Gardon Gage Data - Feasibility Checkout Entry	. 5	7
2.	Gardon Gage Data - Calibration and Material Evaluation Entry		
3.	Thermocouple and Camera Data - Pressure Calibration		
4.	Thermocouple and Camera Data - Thermal Calibration		_
5.	Thermocouple and Camera Data - Material Evaluation		_
6.	RMS Pressure Data - Pressure Calibration		
	Static Pressure Data - Pressure Calibration		
	Static Pressure Data - Thermal Calibration and Material	•	•
	Evaluation	• 6	9
9.	Infrared Data - Thermal Calibration and Material Evaluation		_

T.

93

Ĩ

9

्य ५५%

との

Ä



A-1

NOMENCLATURE

250 SSS SSS SSS SSS

多量多量

Alpha, Alpha angle	Indicated pitch angle, deg
C1 .	Gardon gage calibration factor measured at 70°F, Btu/ft ² -sec-mv
C2	Temperature corrected Gardon gage calibration factor, Btu/ft2-sec-mv
CL	Tunnel event indication of model reaching centerline
CONF	Phase type (1000 for pressure calibration, 2000 for thermal calibration, 3000 for material evaluation)
CP	Pressure coefficient
CST	Central Standard Time
DB, db	Sound pressure level of the root mean square acoustic pressure, decibel
DC	Tunnel event indication of the closing of the tunnel fairing doors
ро	Tunnel event indication of the opening of the tunnel fairing doors
E .	Gardon gage output, mv
EVENT, CAMERA	Indication of tunnel injection sequence (DO, LO, CL, DC, OCL) and camera firings (SHG, IR)
f/xx	IR camera f stop setting xx
FLANGE	Static pressure measured on the Aerothermal nozzle exit flange, psia
GAGE NO., Ti	Gardon gage identification number
H(TT), H(RTT), H(0.915TT)	Heat transfer coefficient based on TT, RTT or 0.915TT; i.e., H(RTT) = QDOT/(RTT-TW), Btu/ft ² -sec-*F
IR	Camera firing indication for infrared color monitor camera
Ki, Kulite No.	Kulite gage identification number
KG	Gardon gage temperature calibration factor, *F/mv

ed processes hereepean personass. (Personasa Personasa) (Personasa) han asasasa (Personasa) (Personasa) (Personasa)

LO Tunnel event indication of the lift-off of the

model in the tank

Free-stream Mach number M

Dynamic viscosity based on free-stream temperature. MU

lbf-sec/ft

Tunnel event indication of the model leaving OCL

centerline

Free-stream static pressure, psia P,PIN

PIC NO. Photograph number for each camera and each run

POD ANGLE Angular rotation of the OMS Pod contour about its

leading edge; positive being trailing edge down,

deg

PT Tunnel stilling chamber pressure, psia

PW Surface static pressure, psia

Free-stream dynamic pressure, psfa

Measured heat-transfer rate, Btu/ft2-sec **QDOT**

Multiplier on total temperature

Free-stream unit Reynolds number, ft-1 RE

Free-stream density, 1bm/ft3 RHO

RMS Root mean square acoustic pressure, psia

RTT Relationship for recovery temperature, product of

a multiplier, R, and the total temperature, TT, °F

RUN Data set identification number

SAMPLE Sample identification letter

Camera firing indication for shadowgraph camera SHG

Stanton number based on TT, RTT, or 0.195TT; i.e.; ST(TT), ST(RTT),

ST(0.915TT)

CANA - AND STATE OF THE PROPERTY OF THE PROPER

 $ST(RTT) = H(RTT)/[RHO*V*(0.2235 + 1.35 \times 10^{-5} (RTT + TW)]$

Free-stream static temperature, 'F

Static tap identification number TAP, STATIC NO.

TG, TGE Gardon gage edge temperature, 'F TGDEL Temperature differential from the center to the edge of the Gardon gage disc, °F

Elapsed time from start of wedge injection

(lift-off), sec

TIME

TIMECL Time at which the wedge reached tunnel centerline,

Central Standard Time or sec

TIMEEXP Time of exposure to the tunnel flow when the data

were recorded, [TIME - (32/57)(TIMEINJ)], sec

TIMEINJ Time of model injection; elapsed time from lift-off

to arrival at tunnel centerline, sec

TIMERD Time from lift-off at which Gardon gage data

were reduced, sec

Temperature measurement from a thermocouple located near the ith Kulite gage, °F TKi

Wedge cavity thermocouple temperature, °F

TPTi Temperature measurement from a thermocouple located

on the ith ESP pressure module, 'F

TSi Thermal model surface, i = 1 to 13,

and backside thermocouple, i = 14 to 16; Sample

backside thermocouple, i = 1 to 3, °F

TT Tunnel stilling chamber temperature, °F

TW Gage surface temperature, °F

Free-stream velocity, ft/sec

WA, WEDGE ANGLE Wedge angle, deg (see Fig. 4)

Orthogonal body axis system directions X, Y, Z

(see Fig. 4 and 5)

Sample emissivity

1.0 INTRODUCTION

The work reported herein was performed by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), under Program Element 921E01, Control Number 9E01, at the request of the National Aeronautics and Space Administration (NASA/JSC), Houston, TX. The NASA project manager was Mr. Jack Barneburg and the Rockwell International (RI) project engineer was Mr. Paul Lemoine. The results were obtained by Calspan Field Services, Inc./AEDC Division, operating contractor for the Aerospace Flight Dynamics testing effort at the AEDC, AFSC, Arnold Air Force Station, Tennessee. The tests were performed in the von Karman Gas Dynamics Facility (VKF), Aerothermal Wind Tunnel (C), on May 27, August 8 and 11, 1983 under AEDC Project No. CA76VC (Calspan No. V41C-3E).

During the sixth flight of the Space Shuttle, portions of the Advanced Flexible Reusable Surface Insulation (AFRSI) on the Orbital Maneuvering System (OMS) Pod failed. The objective of this test program was to investigate the thermostructural performance of the AFRSI under aeroheating conditions to help interpret the physical mechanism by which the failure was incurred.

In order to simulate the aerodynamic environment in which the STS-6 failure occurred, and therefore duplicate the failure in the tunnel, various flow requirements were identified. To investigate the degree to which these flow characteristics could be achieved using the proposed test article, a Feasibility Checkout Phase was performed in a separate tunnel entry. The principal objective of this feasibility study was to maintain and control a turbulent boundary layer separation upstream of the proposed AFRSI location at the low Reynolds number desired for specific flight simulation.

The second tunnel entry began with a Calibration Phase intended to establish the testing environment in terms of static and acoustic pressure distributions and aerodynamic heating levels. The equilibrium temperature of the surface of the insulation material was also determined. The test was completed with the evaluation of 3 AFRSI test samples at total pressures of 20 and 25 psia and total temperatures ranging up to 1115°F.

Inquiries to obtain copies of the test data should be directed to NASA/JSC/ES2, Houston, TX 77058. A microfilm record of the tabulated data has been retained at AEDC.

2.0 APPARATUS

2.1 TEST FACILITY

The Mach 4 Aerothermal Tunnel (C) is a closed-circuit, high temperature, supersonic freejet wind tunnel with an axisymmetric contoured nozzle and a 25 in.-diam nozzle exit, Fig. 1. This tunnel utilizes parts of the Tunnel C circuit (the electric air heater, the Tunnel C test section and injection system) and operates continuously

over a range of pressures from nominally 15 psia at a minimum stagnation temperature of 250°F to 180 psia at a stagnation temperature of 1110°F. Using the normal Tunnel C Mach 10 circuit (Series Heater Circuit), the Aerothermal Mach 4 nozzle operates at a maximum pressure and temperature of 100 psia and 1440°F, respectively. The air temperatures and pressures are normally achieved by mixing high temperature air (up to 1790°F) from the primary flow discharged from the electric heater with the bypass air flow (at 980°F) from the natural gas-fired heater. primary and the bypass air flows discharge into a mixing chamber just upstream of the Aerothermal Tunnel C stilling chamber. Aerothermal nozzle insert (the mixing chamber, throat and nozzle sections) is water cooled by integral, external water jackets. the test unit utilizes the Tunnel C model injection system, it allows for the removal of the model from the test section while the freejet tunnel remains in operation. A description of the Tunnel C equipment may be found in Ref. 1.

2.2 TEST ARTICLE

AND THE STANDARD TO SECRETARING THE SECRETARIAN

X

Y.

The standard Aerotherm Materials Wedge, used for all phases of this test in Tunnel C, is a 12 inch wide by 34 inch long water-cooled flat plate with a backstep 14 inches from the leading edge for material sample installation. The installation of this wedge for the Feasibility Checkout Entry is shown in Fig. 2. The wedge was modified to include lateral extensions upstream of the backstep to reduce any edge effects on the material sample. This is depicted in Fig. 3 and characterized in the sketch of Fig. 4. The wedge was instrumented with Gardon-type heat gages to measure the local wedge heating environment, and the locations of these gages are given in Table 1.

Duplicating the OMS Pod geometry for the test models was a primary simulation requirement. A portion of the actual contour of the pod at the location of the flight failure was used to develop a two-dimensional representation for these test needs. For the feasibility study, a 0.13-scale model, referred to as contour 1 and depicted in Fig. 5, was fabricated from wood and covered with a thin ceramic layer. This shape represented the foremost edge of the OMS Pod up to and including the area of failure. A second wooden model tested was similar to contour 1, except that it had been reduced in size to investigate the controllability of the separation characteristics.

The installation of the wedge for the Calibration and Material Evaluation Phases is shown in Fig. 6. The sketch in Fig. 7 illustrates the locations of the extensive instrumentation installed for the calibrations including Gardon gages, Kulite acoustic pressure gages, and surface static pressure ports. The locations of the static pressure taps and Kulite acoustic sensors are given in Tables 2 and 3, respectively.

For the calibration models and material samples, a 0.20-scale contour of the OMS Pod was used. This shape is depicted in Fig. 8 and a abulat of the contour coordinates is given in Table 4. The pressure hour!, shown in Fig. 9, was constructed of 1020 mild steel. The model has 32 flush orifice pressure taps on the contour surface and 24 Kulite transducers installed adjacent to selected tap positions, located as tabulated in Tables 2 and 3.

The thermal model, shown in Fig. 10, was constructed of Low-temperature Reusable Surface Insulation (LRSI) tile material in the same shape as the pressure model. The model had 13 Chromel®-Alumel® thermocouples located very near the LRSI surface in the location shown in Fig. 10b and tabulated in Table 5. Also, three thermocouples were installed on the backside of the LRSI material.

The mounting hardware for all test models was built with the capability to rotate the entire contoured shape about its leading edge. This provided additional control of the boundary layer separation characteristics and the OMS Pod surface environment. The configuration chosen for all calibration and sample tests was with the pod reclined 8 deg down. The instrumentation locations tabulated and all model sketches are representative of that configuration.

Three AFRSI test samples were conformed to the selected contour and bonded similar to the actual flight installation. A typical sample is shown in Fig. 11, prior to its evaluation. The samples are identified in Table 6, as characterized by the conditioning each underwent before testing. As shown in the photograph, the samples were attached using 17 bolts in a Silfrax border around the AFRSI. The bolt holes were then plugged with uncoated LRSI material to provide a smooth surface. Each sample had three Chromel-Alumel thermocouples installed on its undersurface.

To insure a turbulent boundary layer along the wedge surface, boundary layer trips were installed one inch downstream of the wedge leading edge. The trip balls were 0.093 inches in diameter and were arranged in a three-row configuration, as shown in Fig. 4.

Posttest photographs of the thermal body and the AFRSI samples are shown in Fig. 12.

2.3 TEST INSTRUMENTATION

CONTRACTOR OF THE PARTY OF THE PROPERTY OF THE PARTY OF T

The instrumentation, recording devices, and calibration methods used to measure the primary tunnel and test data parameters are listed in Table 7a along with the estimated measurement uncertainties. The range and estimated uncertainties for primary parameters that were calculated from the measured parameters are listed in Table 7b.

To define the convective heating environment experienced by the material specimens, Gardon-type heat transfer gages were mounted in the wedge surface upstream of the OMS body, as shown in Fig. 4. Heat-transfer rate measurements were obtained with high-temperature Gardon gages which were supplied and calibrated by the AEDC. The gages were 0.25-in. in diameter with a sensing foil thickness of 0.010-in. They were instrumented with Chromel-Alumel thermocouples which provided the gage edge temperature measurement. Gage edge temperatures, together with the sensing foil thermocouple output, were used to determine the gage surface temperatures and corresponding gage heat-transfer rate. These data were then used to compute the local heat-transfer coefficient and Stanton number.

The model surface static pressures were measured with two Pressure Systems Incorporated Model ESP-32 pressure modules with a range of +15 psid. The ESP-32 pressure sensor module has 32 ports with a silicon pressure transducer per port that can be digitally addressed and calibrated on line. The ESP-32 modules were installed inside the OMS Pod contour in close proximity to the static taps, thus reducing the pressure stabilization time required. The static pressures were measured only during the second entry.

The surface dynamic pressure levels were measured with RI-supplied and installed Kulite sensors and transducers. These dynamic signals were recorded on multi-track tape recorders for user analysis. Selected channels (15) were routed to AEDC rms meters which were incorporated in the data acquisition system.

Several Chromel-Alumel thermocouples were used on the various test models to monitor critical model temperatures. The pressure model had thermocouples near Kulite gages 105, 110, 114, 116 and 124, monitored to insure they did not overheat and fail. The thermal model had 13 surface thermocouples to measure its surface equilibrium temperature, and these were located as shown in Fig. 10b and tabulated in Table 5. All AFRSI test samples and the thermal model had 3 thermocouples on the backside of the insulation to monitor the support structure temperature. The wedge cavity, where all the gage lead wires were routed, and both ESP modules were instrumented to monitor operating temperatures in these areas.

The infrared system which was used to measure model surface temperatures utilizes an AGA® Thermovision 680 camera which scans at a rate of 16 frames per second. The camera has a detector which is sensitive to infrared radiation in the 2 to 6 micron wavelength band. A description of the system is given in Ref. 2.

A total time of exposure to the tunnel flow is required for data reduction. All the events which occur during a run are timed using the digital clock in the DEC-10 computer, which processes all data from the continuous tunnels.

A variety of cameras was used to record the response of the materials to the tunnel environment. The cameras, frame rates and film identifications are summarized in Table 8. A plumb line was attached to the aft window to provide a vertical reference in the shadowgraph stills.

3.0 TEST DESCRIPTION

3.1 TEST CONDITIONS

The nominal free stream test conditions are given below.

M	PT, psia	TT, °F	Q, psfa
4	20	350	225
1	ſ	840	220
		1440	214
1	25	340	281
	•	1440	270
	30	330	336
Ì	1	1440	320
· į	60	1440	641

A test summary showing a detailed account of all runs of each phase is presented in Table 9.

3.2 TEST PROCEDURES

CANADA TARA BANAN SANTE INTERNATION OF THE SANTES

In the VKF continuous flow wind tunnels (A, B, C), the model is mounted on a sting support mechanism in an installation tank directly underneath the tunnel test section. The tank is separated from the tunnel by a pair of fairing doors and a safety door. When closed, the fairing doors, except for a slot for the pitch sector, cover the opening to the tank and the safety door seals the tunnel from the tank area. After the model is prepared for a data run, the personnel access door to the installation tank is closed, the tank is vented to the tunnel flow, the safety and fairing doors are opened, and the model is injected into the airstream. After the data are obtained, the model is retracted into the tank and the sequence is reversed with the tank being vented to atmosphere to allow access to the model in preparation for the next run. A given injection cycle is termed a run, and all the data obtained are identified in the data tabulations by a run number.

The standard AEDC materials wedge testing technique was used to support the calibration bodies and material samples and provide the desired local flow condition. A detailed description of this technique may be found in Ref. 3.

Instrumentation outputs were recorded using the digital data scanner in conjunction with the analog subsystem. Data acquisition from all instruments other than the infrared camera was under the control of a Digital Equipment Corporation (DEC) PDP 11/40 computer, utilizing the random access data system (RADS). The data system was started prior to injection, while the model was still in the tank. All the transducer outputs were recorded at the rate specified in Table 10. Additional loops of data were recorded each time the sequence cameras were triggered, thereby providing a time point for each photograph. The data were transmitted to a DEC-10 computer for processing.

The infrared system operates independently of the RADS. During a run the AGA 680 infrared camera scanned the model to produce a complete picture at the rate of 16 frames per second. The camera output was recorded on analog tape and simultaneously displayed on a color television monitor. The developing color patterns were observed as the model surface temperature increased, and the monitor was photographed as described in Table 10 to provide a permanent record. The camera output was also fed to an analog-to-digital converter under the control of a PDP 11/34 computer. Every 4 seconds a single frame was digitized and transmitted to the DEC-10 computer. An additional loop of data from the RADS system was recorded each time a frame was digitized to provide a record of test conditions at the time infrared data were obtained.

Characteristics of the data acquisition peculiar to each test phase will be described individually.

3.2.1 Feasibility Checkout Phase

To determine the flow separation and reattachment characteristics of the proposed OMS Pod contour, several runs of oil flow visualization were obtained at several free stream pressures. The wedge and wooden contoured models were painted with a high-temperature black paint just prior to the application of the white oil. The oil was applied with a sponge to provide a sheet of oil over the entire surface. The model was injected at the desired wedge angle and remained on centerline for at least 5 seconds. During the exposure, views of the oil flow progression were videotaped from the top window port and the forward side window. A typical frame of the tape from the top view is shown in Fig. 13. Also, the shadowgraph system was videotaped and helped qualify the flow on the wedge and OMS Pod model.

Heat transfer measurements were taken on the wedge to define the convective heating environment in the area upstream of the wooden contour.

A STEET OF THE STORES OF THE S

3.2.2 Pressure Calibration Phase

The flow environment on the test article and the wedge plate was extensively measured at many model attitudes and flow conditions to quantify these parameters for the material evaluations. The pressure calibration body, instrumented for static and dynamic pressure measurements, was installed on the aerotherm wedge for this phase.

The injection data-taking sequence was initiated by positioning the wedge at the desired wedge angle and beginning the tape recording of the Kulite transducer outputs. After several seconds, the tunnel doors were opened, the model was injected to the tunnel centerline and the doors were closed. After nominally 20 seconds on centerline, the doors were opened, the model was retracted, the tape recorders were stopped and the data-taking sequence was completed. For the shorter calibration runs, nominally 6 seconds on centerline, the doors were left open throughout. While on centerline, the convective heat transfer environment, the static pressure distribution and selected rms pressure levels were determined. Also, shadowgraph still photographs recorded the shock wave pattern and general TV coverage was videotaped.

3.2.3 Thermal Calibration Phase

To quantify the surface equilibrium temperature expected on the AFRSI samples, the thermal model was installed on the wedge and injected into the tunnel for an extended period of time. Several of the surface thermocouples were monitored during the run to determine when the LRSI had reached an equilibrium temperature. Starting at the maximum tunnel total temperature, 1440°F, four runs of thermal calibrations were achieved until a desired maximum surface equilibrium temperature was obtained. Infrared data were also obtained on the thermal model surface. Also, low and high speed movie coverage of the LRSI was recorded for the approximate 4 minute tunnel exposure.

3.2.4 Material Evaluation Phase

AFRSI test samples A, B and F were evaluated in the tunnel. The test article was positioned at the desired wedge angle and the datataking sequence was initiated at lift-off from the tank.

The samples remained on centerline nominally 250 seconds, or until a failure was incurred. The convective heat transfer environment and the static pressure distribution on the wedge were determined. The infrared camera was continuously updating the sample surface temperature, and movies and still photographs were taken of the color IR monitor. Movies of the sample were taken starting at lift-off. High speed movies were initiated when the failure was first beginning and the physical apearance of the sample first changed.

3.3 DATA REDUCTION

Measured stilling chamber pressure and temperature and the calibrated test section Mach number were used to compute the free-stream parameters. The equations for a perfect gas isentropic expansion from stilling chamber to test section were modified to account for real gas effects.

Data measurements obtained from the Gardon gages are gage output (E) and gage edge temperature (TGE). The gages are direct reading heat flux transducers and the gage output is converted to heating rate by means of a laboratory calibrated scale factor (Cl). The scale factor has been found to be a function of gage temperature and, therefore, must be corrected for gage temperature changes,

$$C2 = C1 f(TGE)$$
 (1)

Heat flux to the gage is then calculated for each data point by the following equation:

$$QDOT = (C2)(E)$$
 (2)

The gage wall temperature used in computing the gage heat-transfer coefficient is obtained from two measurements - the output of the gage edge thermocouple (TGE) and the temperature difference (TGDEL) from the

gage center to its edge. The measured values used in the reduction equations were filtered using 4 consecutive data points taken within less than a half a second, and typically just one second after centerline. TGDEL is proportional to the gage output, E, and is calculated by:

$$TGDEL = (KG)(E)$$
 (3)

The gage wall temperature is then computed as

$$TW = TGE + 0.75 TGDEL$$
 (4)

where the factor 0.75 represents the average, or integrated, value across the gage.

The heat transfer coefficient for each gage was computed using the following equation

$$H(RTT) = \frac{QDOT}{(RTT-TW)}$$
 (5)

where QDOT and TW were obtained from gage measurements. The product RTT represents the recovery temperature, which is not known at each measurement location. H(RTT) was calculated for values of R of 1.0 and 0.915.

The heat transfer coefficient was then converted to Stanton number by:

$$ST(RTT) = \frac{H(RTT)}{(RHO)(V)[0.2235 + 1.35 \times 10^{-5}(RTT + TW)]}$$

Prior to each operational shift, the two ESP-32 modules with a total of 64, +15 psid transducers were calibrated. From these data, scale factors for each transducer were calculated. Prior to each test run the modules were referenced to a hard vacuum to obtain zero readings for each transducer. The appropriate scale factor and zero reading were used to determine the pressure on each transducer. Five consecutive readings, taken within a half a second, were averaged to obtain the static pressure. The readings were obtained when the tunnel doors were closed, excert for the shorter calibration runs, and the model was on centerlin. It is was nominally 10-20 seconds after centerline was reached. A recoefficient, CP, was also calculated from:

$$CP = \frac{144 (PW-P)}{Q}$$

The rms pressure measurements were obtained by sampling the rms meter output and multiplying this output by the user-supplied sensitivity factors. These were related to decibel level by:

$$db = 20 \log_{10} \frac{RMS}{2.9 \times 10^{-9}}$$

Ę.

As discussed in Section 3.2, the output of the IR camera is displayed in real time on a color television monitor. A 70mm camera was used to photograph the monitor screen simultaneously with a single frame digitizing process. An example of a monitor screen photograph is given in Fig. 14. On the television monitor the temperature range, which the system is set up to measure, is divided, in a nonlinear fashion, into ten separate colors, starting with blue for the lowest temperature and progressing through white for the highest. Each color then represents a temperature band within the total range, and the interface between two colors corresponds to one particular temperature. This provides a view in which unusual temperature patterns would be more easily discerned than in the digital data tabulations.

As noted in Section 3.2, digital infrared data were obtained at the rate of one frame every four seconds. One complete frame of infrared data consists of 70 scan lines with 110 points per line for a total of 7700 discrete but overlapping spots. For most test installations the field of view is such that the model does not fill the complete frame. In order to save storage space in the computer, only the portion of the frame which contains good model data is digitized. For the AFRSI and LRSI test articles, a typical area of interest (see Fig. 14) was approximately 80 lines by 70 points (5600 discrete spots). For each spot, the camera output is digitized and converted to a temperature reading by means of an equation derived from basic laws of radiation and incorporating various constants peculiar to this system. These constants are obtained from laboratory calibrations using a standard black body source.

The temperature calculations were carried out using surface emissivity values determined from AEDC reflectivity measurements made at room temperature. A monochromatic light source was used to illuminate the material sample. The hemispherical spectral reflectivity was then measured. Assuming the sample is opaque to radiation at each discrete wavelength at which reflectivity was measured, and assuming that the material acts as a diffuse-gray surface, the emissivity (E) was determined from the reflectivity as follows:

= 1 - REFLECTIVITY

This reflectivity measurement was made at several wavelengths. The emissivity values for each wavelength were weighed by the response characteristic of the IR camera detector at that wavelength, and the result integrated over the total wavelength range of the IR detector to provide a value of total emissivity. Emissivity values of 0.82 for the LRSI tile (thermal model) and 0.68 for the AFRSI were thus determined.

Note that hemispherical reflectivity measurements were used to evaluate emissivity. Therefore, strictly speaking, the emissivity calculated above is the hemispherical emissivity for an opaque surface. A reasonable approximation (within 2 to 5 percent) for gray-body diffuse emitters is that the directional emissivity is equal to the hemispherical emissivity for surface angles within 40 degrees of the normal. Therefore, the temperature data produced from IR measurements during this test are valid only for surfaces aligned within 40 degrees of horizontal.

The calculated temperatures were tabulated in a two-dimensional array in which each spot location is defined by its Line number and Point number. In order to use the IR data, it is necessary to define the model position in terms of Line and Point number. This was done by taking wind-off infrared scans of the wedge, with a specimen attached, in the tunnel at the test attitude. A wire was positioned along the edge of the specimen, and an external electrical current was provied causing the wire to heat up. Thus, it was possible to locate the specimen on the IR video monitor via the outline produced by the hot wire. A marker is then superimposed on the video monitor by the IR system electronics. This marker is a matrix of dots representing each spot in the digitized IR data. The marker can be controlled so that individual Lines or Points may be identified. In this manner the Lines and Points corresponding to the sample location were defined. Figure 14 identifies the location, in terms of Lines and Points, of several points The actual field digitized covered the range of all of these points, so that the field did not have to be changed during the test.

The spot size is a function of the camera detector size, the camera optics, and the distance to the test article. However, it must be emphasized that each IR "spot" was about 0.35 in. in diameter and that the measured radiation from this size spot is used to calculate the surface temperature. Also, note that this spot is for a surface normal to the IR camera (i.e., in the horizontal plane). Measurements on surfaces inclined relative to the camera will be influenced by model temperatures over an area larger than this spot size.

3.4 UNCERTAINTY OF MEASUREMENTS

I WHISTON , BUTCHER WITCHES AND ADDITION OF THE SECOND SECOND TO THE SECOND SEC

3

U

Ĉ.

In general, instrumentation calibrations and data uncertainty estimates were made using methods recognized by the National Bureau of Standards (NBS). Measurement uncertainty is a combination of bias and precision errors defined as:

$$v = \pm (B + t_{95}s)$$

where B is the bias limit, S is the sample standard deviation and t_{95} is the 95th percentile point for the two-tailed Student's "t" distribution (95-percent confidence interval), which for sample sizes greater than 30 is taken equal to 2.

Estimates of the measured data uncertainties for this test are given in Table 7a. The data uncertainties for the measurements are determined from in-place calibrations through the data recording system and data reduction program.

Propagation of the bias and precision errors of measured data through the calculated data was made in accordance with Ref. 4 and the results are given in Table 7b.

4.0 DATA PACKAGE PRESENTATION

A sample data tabulation is presented in Appendix III. Included is a tabulation of the heat-transfer data for the feasibility study. For the pressure calibrations, samples of the heat transfer data, the static pressure data, the rms pressure data and the thermocouple data are included. For the thermal calibrations, samples of the heat transfer data, the static pressure data, the surface thermocouple data and an IR tabulation are included. For the material evaluation phase, samples of the heat transfer data, static pressure data, sample thermocouple data and an IR tabulation are included.

Defended (respersion received) besetsted (respension) respension (respension) respension (respension)

REFERENCES

- 1. Test Facilities Handbook (Eleventh Edition), "von Karman Gas Dynamics Facility, Vol. 3," Arnold Engineering Development Center, April 1981.
- Boylan, D. E. Carver, D. B., Stallings, D. W., and Trimmer, L. L.
 "Measurement and Mapping of Aerodynamic Heating Using a Remote
 Infrared Scanning Camera in Continuous Flow Wind Tunnels," AIAA
 Preprint 78-799, April 1978.
- 3. Matthews, R. K. and Stallings, D. W. "Materials Testing in the VKF Continuous Flow Wind Tunnels," AIAA 9th Aerodynamic Testing Conference, Arlington, TX, June 7-9, 1976.

COUNTY WELLSON, CONSTRUCT ASSESSMENT CONTRACT RELEASES

C

1

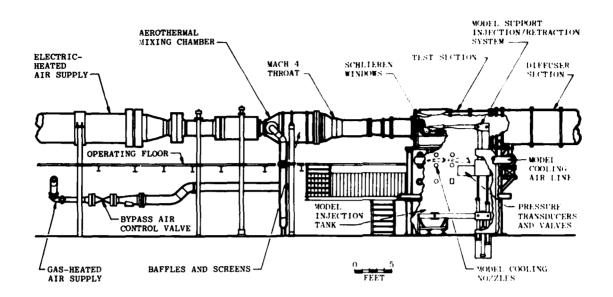
33

ĝ

PASSA TREPRESENTING SOCIONAL PROCESSOR INVESTER SAME

4. Thompson, J. W. and Abernethy, R. B. et al. "Handbook Uncertainty in Gas Turbine Measurements," AEDC-TR-73-5 (AD755356), February 1973.

APPENDIX I ILLUSTRATIONS



H

8

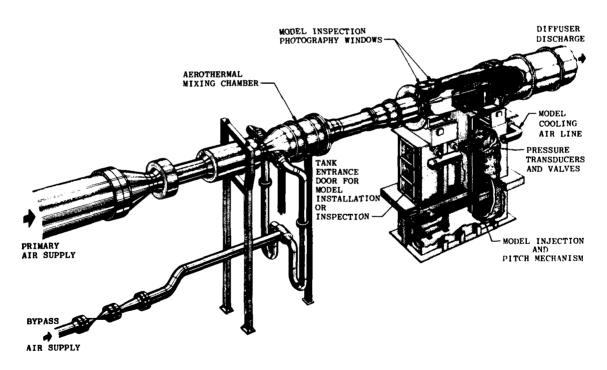
Trist.

B

※※ 金属へ

a. Tunnel assembly

SSAST NOODOOS ROGGOSSE KEEREERE KEEREERE INSTAANT IRREBERG INDEED I LEGEOOOF IGGGGGGG IGGGGGGG INDAADON



b. Perspective of tunnel test section area

Fig. 1 Tunnel C Mach 4.0 Configuration

the second

State Market 20 St.

A RE TANK

A ALPANA TO SERVICE

TANK TO THE PARTY

THE WASHINGTON

AND SOME THE PROPERTY OF THE PROPERTY OF THE PARTY OF THE

N.

9

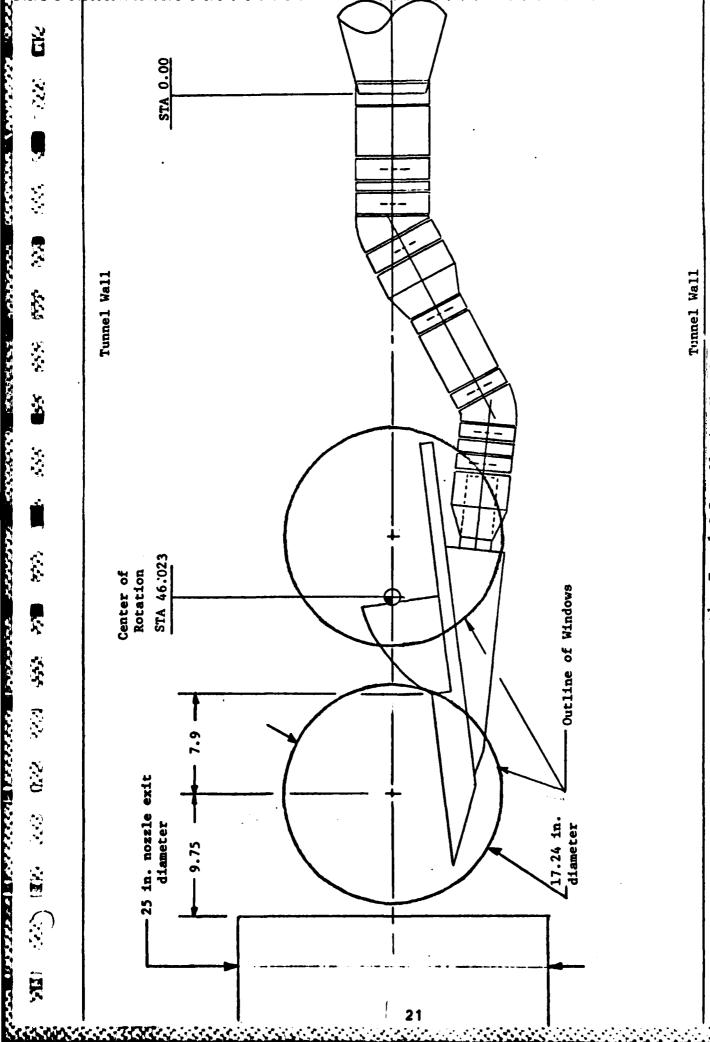
The state of the s

3

a. Tunnel C installation of Test Article - Feasibility Checkout Entry Tunnel C Installation Photograph, M = 4 Figure 2.

A CONTRACTOR OF THE CONTRACTOR

FIOW



PRINCE LABORATES, STORAGES STRUCKUR, ESTERNISC (ALASKAND)

Tunnel C Installation Sketch Concluded Figure 2.



Ş

*

3

1

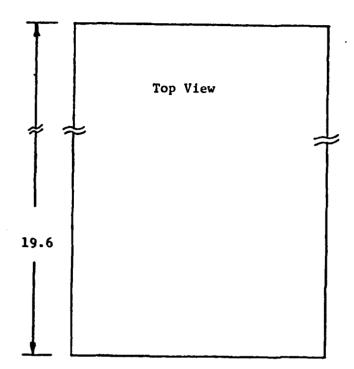
• • •

Z

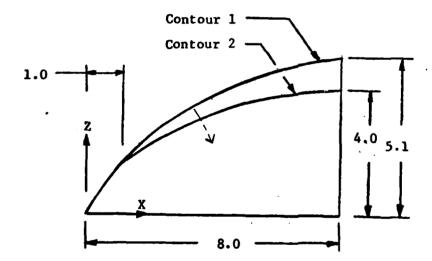
Ė

Figure 3. Feasibility Test Article in Tunnel Tank

Figure 4. Aerotherm Wedge - Feasibility Checkout Entry



Contour 1*	(0.13 scale)
X.in.	Z,in.
0	0
0.155	0.362
0.554	1.069
0.788	1.375
1.304	1.933
2.566	2.905
3.305	3.352
4.204	3.806
5.265	4.249
6.536	4.675
8.042	5.1.00



AND SECURIOR SECURIOR

*Note: Contour 2 was untained by rotating the identical contour downward as shown above.

Figure 5. Feasibility Test Models



....

A CONTRACT C

X

CO

3

1

3

Ė

Installation of Test Article - Calibration and Material Evaluation Entry Tunnel C Installation Photograph, M = 4 Figure 6.

(

4

C Z

٠ ن

No.

X

a. Aerotherm Wedge

Gage locations.

Notes:

Gage locations.

Test Article - Calibration and Material Evaluation Entry Figure 7.

`

į

N. 18.4

b. Wedge Pressure Instrumentation Figure 7. Concluded

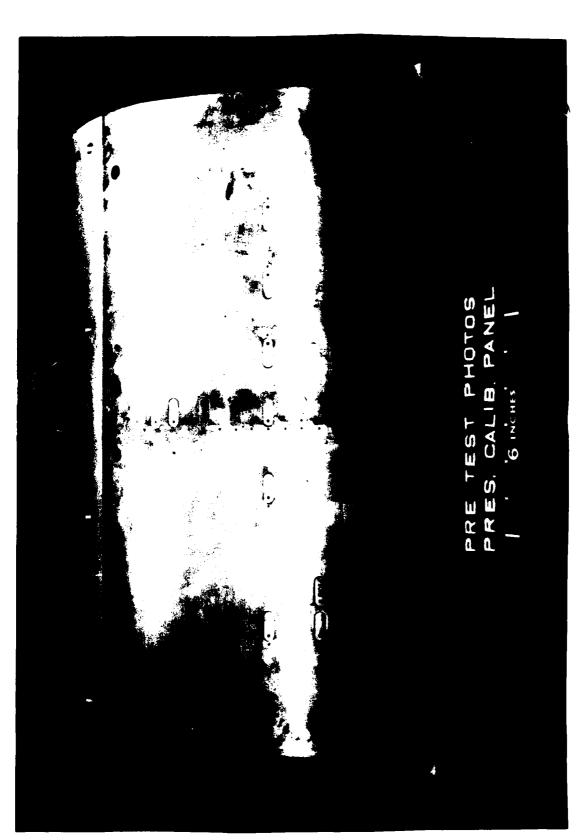
ý.

Z

£.

See Table 5 for coordinates of nominal 0.20-scale contour

Figure 8. Contour of OMS Pod Test Models

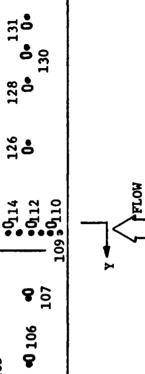


6. 20 c. st

1. 8. 1. A. 1.

a. Pressure Calibration Model Figure 9. Pressure Calibration Test Article

KASAL BARABAS, YARAHAN ARBABAS WASAKSA MASAMAN BARABAS KASASASI MASAMAN BARABASI KASASASI MASAKSA

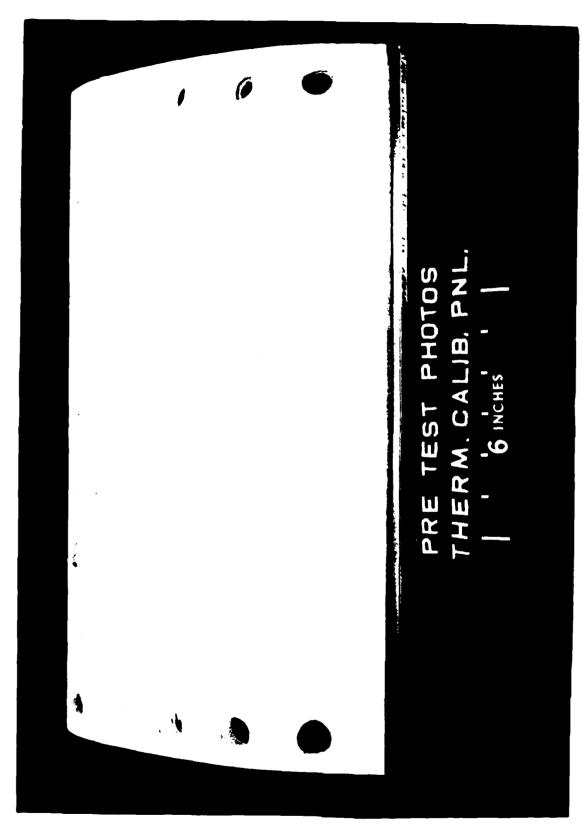


NOTES:

1. See Tables 3 and 4 for instrumentation locations.
2. Identifying numbers refer to both types of instrum

Identifying numbers refer to both types of instrumentation, except on centerline.

b. Pressure Calibration Model Instrumentation Sketch Concluded Figure 9.



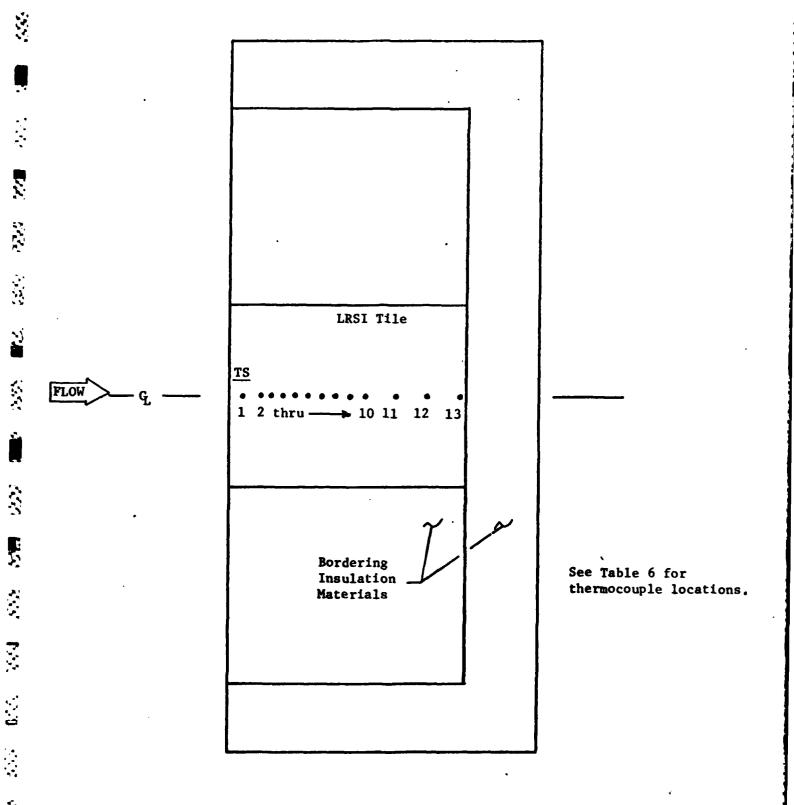
}

S

100

121

a. Thermal Calibration Model Figure 10. Thermal Calibration Test Article



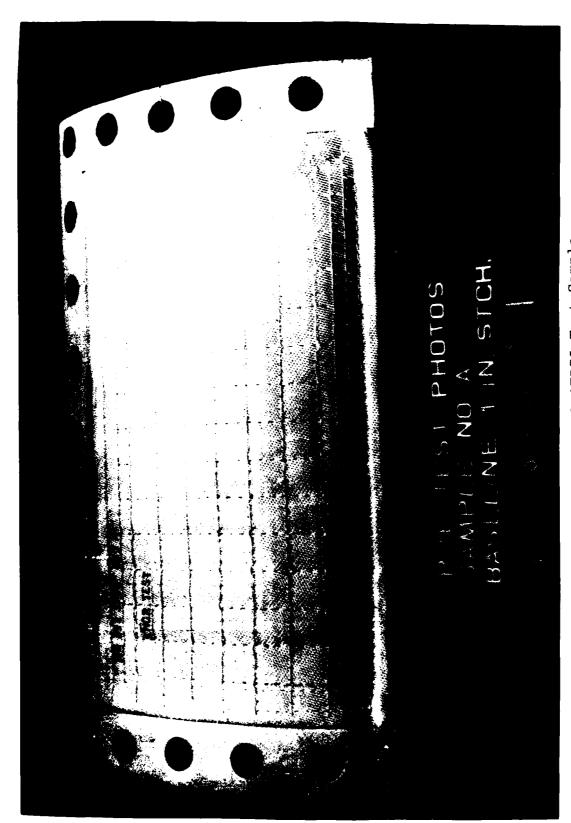
STATESTS OF THE STATES OF THE

SKI.

1

Ü

Thermal Calibration Model Instrumentation Figure 10. Concluded



, . ,

3

Ś.

Ş

Į.

\$0

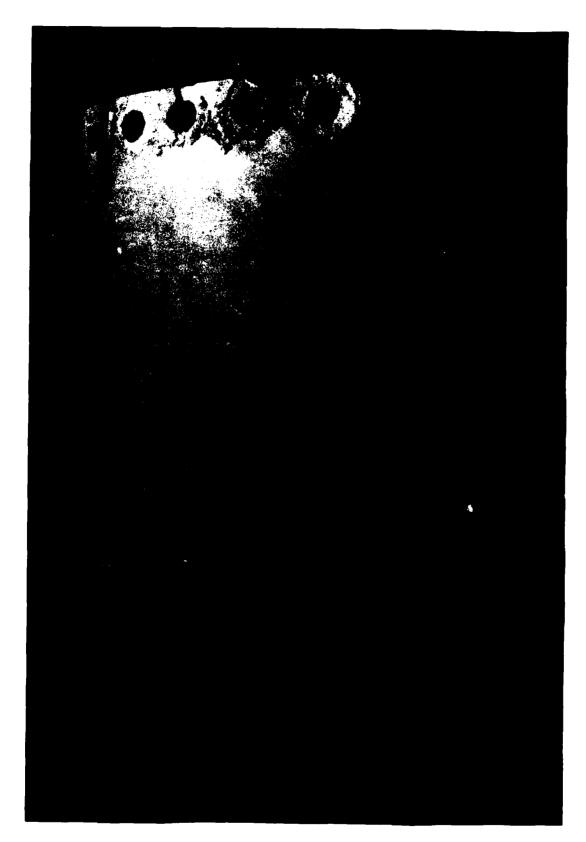
7

X.

S

3

Figure 11. Typical AFRSI Test Sample



25.50

ある

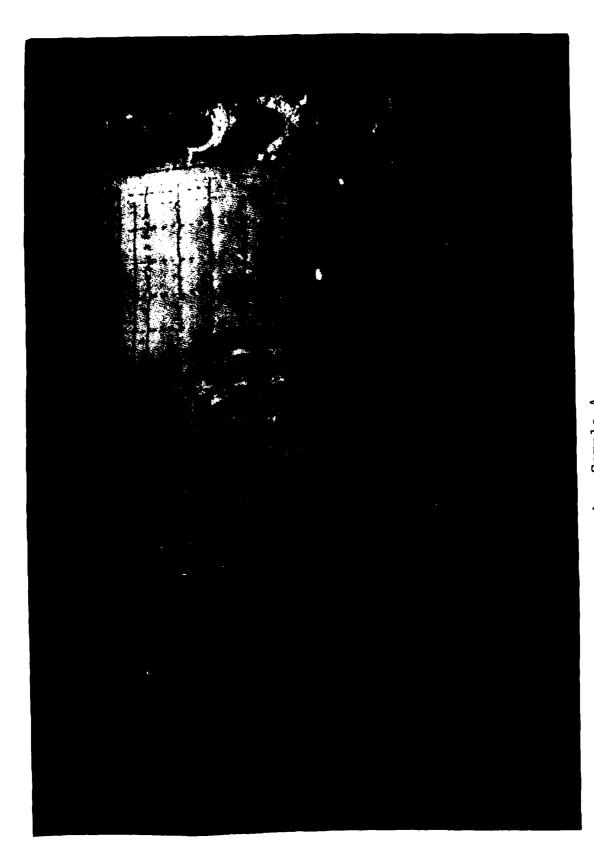
17 18

1

3

a. Thermal Calibration Panel Figure 12. Tunnel-Exposed Test Articles

TOSSESSI HOSSESSI HOSSESSI



Z.

3

Q.

1

}

b. Sample AFigure 12. Continued

TRESPORTED TO PERSONAL PROPERTY OF THE PROPERT



·水

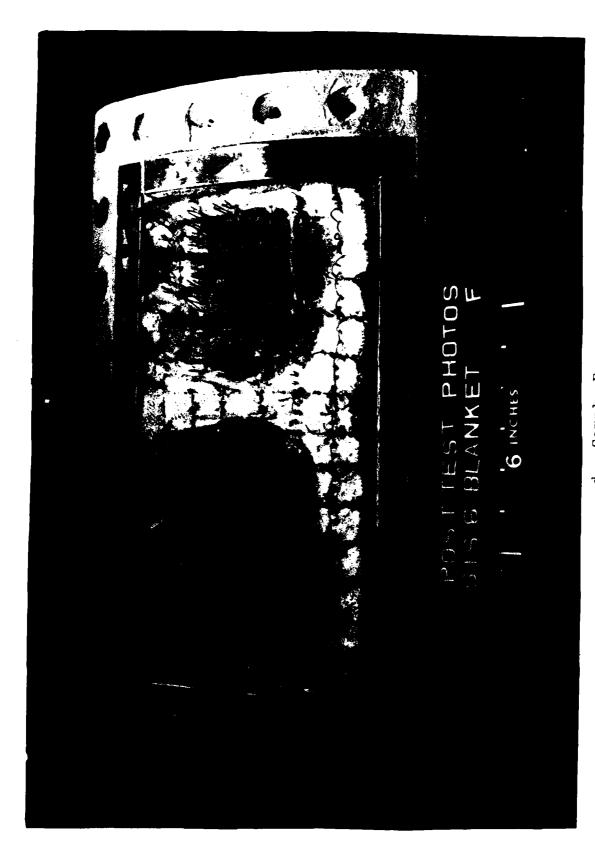
3

Š

, . 1, .

¥.

c. Sample B Figure 12. Continued



第二十二 美國教養養

一年 をなるのである

· 大學 (1986) (1986)

Comment of the said

1 の一大

の水の味の味の

3

Ş

2

Figure 12. Concluded Sample F

1

S

3

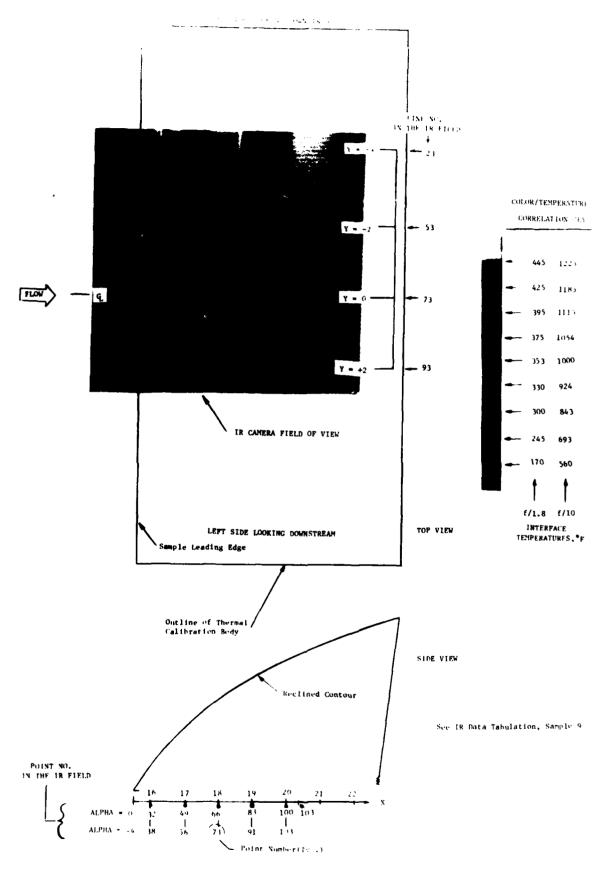
37

77.7

Ė

View from above

Figure 13. Typical Oil-Flow Visualization Data



Proprieta (1908) | 1908) | 1808) | 1808) | 1808) | 1808) | 1808) | 1808) | 1808) | 1808) | 1808) | 1808) | 1808)

Figure 14. Spatial Correlation of Digitized IR Data with Camera Field of View and Test Article

APPENDIX II

TABLES

Table 1. Gardon Heat Gage Locations

Gage No.*	<u> </u>	<u>Y</u>
1	13.5	4.50
2		3.10
3	Ψ	1.80
4	7.5	0
5	9.0]
6	10.5	
7	12.0	
8	13.5	₩
9		-1.80
10		-3.10
11		-4.50

*Note: For the Feasibility Checkout Phase, these gages were referred to as T1 through T11.

Table 2. Static Pressure Tap Locations a. Wedge Taps

TAP	_ <u>x</u> _	<u> </u>	TAP	<u>x</u>	<u>Y</u>
1	10.5	2.5	11	11.5	0.25
2 .	12.0		12	12.0	1
3	13.5		13	12.5	
4	14.5		14	13.0	
5	15.25	₩	15	13.5	
6	7.0	0.25	16	14.25	
7	8.0	1	17	14.5	
8	9.0		18	15.0	
9	10.0		19	15.25	\
10	11.0	\			

ŝ

. . .

it H

Table 2. Concluded b. Pressure Calibration Panel Taps

	 		
Тар	<u> </u>	Y	<u>z</u>
101	16.68	6.5	1.61
102	17.80	6.5	2.60
103	19.07	6.5	3.40
104	16.68	5.5	1.61
105	17.80	5.5	2.60
106	16.68	4.5	1.61
107	16.68	2.5	1.61
108	19.07	2.5	3.40
109	15.76	0.25	0.43
110	16.05	0.25	0.84
111	16.35	0.25	1.23
112	16.68	0.25	1.61
11,3	17.03	0.25	1.96
114	17.41	0.25	2.29
115	17.80	0.25	2.60
116	18.21	0.25	2.89
ł			

Тар	<u> </u>	Y	<u>z</u>
117	18.63	0.25	3.16
118	19.07	0.25	3.40
119	19.51	0.25	3.63
120	19.97	0.25	3.84
121	20.42	0.25	4.05
122	20.88	0.25	4.24
123	21.35	0.25	4.42
124	21.82	0.25	4.60
125	22.76	0.25	4.92
126	16.68	-2.5	1.61
127	19.07	-2.5	3.40
128	16.68	-4.5	1.61
129	19.07	-4.5	3.40
130	16.68	-5.5	1.61
131	16.68	-6.5	1.61
132	19.07	-6.5	3.40

Table 3. Kulite Dynamic Pressure Gage Locations

Wedg	ge Kulite Gages	3
<u>Kulite</u>	<u> </u>	Y
1	10.5	2.25
2	12.0	
3	13.5	
4	14.5	
5	15.25	4
6	7.0	0
8	8.7 5	1
9	10.0	
10	11.0]
12	11.75	
14	13.0	
17	15.0	
19	15.25	₩

	ä		T	able 3	. Kulii	te Dynamic Pre	ssure C	ace In	cati
	Š		•			- Dynamic IIC		ape no	
	Ņ				We	dge Kulite Gag	es		
	3			j	Kulite	<u> </u>	_	Y	
	_				1	10.5	:	2.25	
					2	12.0			
	.				3	13.5			
	33				4	14.5			
	W)			1	5	15.25		Ą	
	K Kij				6	7.0)	
	43			Ì	8	8.75			
	• र्				9	10.0			
	~				10	11.0			
	T.A				12	11.75			
	Š				14	13.0	i		
	n.			1	17	15.0	-	,	
					19	15.25	'	7	
	Ŋ		 						
	·N					ibration Panel			
		Kulite	X	Y	<u>Z</u>	Kulite	X	<u>Y</u>	Z
	~ .	101	16.68	6.25	1.61	118	19.07	0	3.40
	Ş	102	17.80	6.25	2.60	120	19.97	0	3.84
	1 2	103	19.07	6.25	3.40	122	20.88	0	4.24
	77	104	16.68	•	1.61	124	21.82	0	4.60
		105	17.80	5.25	2.60	125	22.76	0 -2 25	4.92
	••,	106	16.68	4.25	1.61	126	16.68	-2.25	
1		107 108	16.68 19.07	2.25 2.25	1.61 3.40	127 128	19.07 16.68	-2.25 -4.25	
		110	16.05	0	0.84	128	19.07	-4.25 -4.25	
		112	16.68	0	1.61	130	16.68	-4.25 -5.25	
	~	114	17.41	0	2.29	131	16.68	-6.25	
•		114	18.21	0	2.89	131	19.07	-6.25	
	()	110	10.21		2.07	132		-0.23	J.4(
•									
						45			

Table 4. Coordinates of 0.2-Scale Partial OMS Pod Contour

X,in.	Z,in.
0 0	0 .
0.0975	0.2625
0.2391	0.5574
0.3747	0.8052
0.5310	1.1181
0.6846	1.3776
0.8529	1.6284
1.0329	1.8879
1.2129	2.1150
1.4193	2.3598
1.6170	2.5782
1.8177	2.7846
2.0064	2.9736
2.5317	3.4365
2.9361	3.7611
3.2724	3.9972
3.6294	4.2627
3.9480	4.4691
4.2489	4.6785
4.6266	4.8969
5.0841	5.1564
5.4765	5.3748
5.9898	5.6226
6.4680	5.8554
7.2204	6.1860

Note: See Fig. 8 for definition of contour coordinates.

Table 5. Thermal Model Surface Thermocouple Locations

STATE OF THE PROPERTY OF THE P

E

N

T/C No.	x	<u>Y</u>	_ <u>z</u>
1	15.90	0	0.63
2	16.52	1	1.42
3	16.86		1.79
4	17.22		2.13
5	17.60		2.45
6	18.00		2.75
7	18.42		3.03
8	18.85		3.28
9	19.29		3.52
10	19.74		3.74
11	20.65		4.15
12	21.58		4.51
13	22.53	V	4.84

Table 6. AFRSI Sample Descriptions

Sample No.	Description
A	Baseline (1-inch stitching)
В	Baseline thermally conditioned (TC) to 1100°F
F	STS-6 blanket (panel removed after STS-6 mission)

				Tab1	Table 7. E	Estimated Uncertainties Basic Measurements	stimated Uncertain Basic Measurements	rtain	ties		,
				MITE	ESTIMATED MEASUREMENT®	EMENT					
	Preci	Precision Index (S)		8.5	Bias (8)	Uncertainty ±(B + 195S)	ainty 1958)	<u> </u>			
Designation	Percent of Reading	Unit of Messure-	Degree of mobesti	Percent to Reading	lo lint Messure- nent	Percent of Reading	to sint -stuz se from	Range	Type of Measuring Device	Type of Recording Device	Method of System Calibration
STILLING CHANBER PRESSURE, PT, pala		0.12	> 30		0.75		0.425	7156	Wisneko variable Feluciance pres- sure transducer	Digital data acquisi- tion system analog-to- digital converter	In-place application of multiple pressure levels measured with a pressure measuring device calthrates
							•		,		in the standards laboratory
TOTAL TEMPERATURE,			×30		a		•	32 to	9 ,		Thermocouple verifi-
			730	0.375		(.3755 + 2)			a Tonocompan	instrument digital	cation of NBS con- formity/voltage sub- atitution calibration
PITCH ANGLE, ALPI,		0.026	730				0.08	S	Potentiometer		Heldenhain retary encuder ROD700 Resolution:0.00069 Overall accuracy:
718E		5×10-4	30	Runtime(seg)x 5x10-6	×(30-0	Rustine(sec)x 5x10-6 + 10-3		me to 365 days	ms to Systron Donner Digital data 365 daystime code generatortion system	acquist-	Instrument lab call- bration against Bureau of Standarda
QDOT, BTU/ft2-sec	1.5	0.015	88 y	~ ~		(0.03 + 2\$) 5\$		1 to 10	Gardon Gage	Digital data acquisi- tion system analog-to- digital converter	Radiant heat source and secondary standard
E, BV	0.1		730	6.0		(0.2% + 0.01)	0.01)		DEC-10/Multiverter Preston Amplifier		Millivolt standard, referenced to lab
TEMPERATURE, TGE,		-	>30		~		~	32 to	CrAl Thermocouple		
Tsi, or			>30	3/8%		(3/8% + 3)		530 to			
in Spot Tempera- ture, of	6.9		ğ	ö.		1.3	-		AGA 680 Therms	Analog-to-Digital Converter	Secondary Standard Black Body Temperature Source
								·			

*REFERENCE: Thompson, J. W. and Abernethy, R. B. et al. "Handbook Uncertainty in Gas Turbine Massurements." AEDC-TR-73-5, February 1973 NOTES:

the property of the property o

H

•

		Device Recording Device System Calibration	Analog to digital converter/digital data of multiple pressure acquisition system pressure measured with device calibrated in the standards laboratory laboratory
pa		Type of Measuring Device	0.24p / Pressure Systems 15 incorporated Sensor Sensor
Table 7. Continued a. Concluded	EMENT* Uncertainty ±(B + totS)	Percent of Reading Init of Messure-	0.03
Tabl	Bias Un	Percent of Resding Unit of Messure-	0.01
		Degree of Freedom	N
	Precision Index (S)	to tinU -sauzesM finse	4 10 -3
	Precis	Percent of Beading	
		Princtor Designation	STATIC PRESSURE, PW.

RECESTANCE: Thompson, J. W. and Abernethy, R. B. et al. "Handbook Uncertainty in Gas Turbine Measurements." AEDC-TR-73-5, Pebruary 1973 NOTES:

GC-35 (Combines GC-35 & GC-120) 1/82

1

TENESSEE FOR THE SECOND PROPERTY OF THE SECOND TO SECOND TO SECOND THE SECOND

Table 7. Concluded b. Calculated Parameters

•

学科 (安美

				ESTIMATED	TED MEASUREMENT*	EMENT*		
	Precision (S)	ion Index (S)		Bi (B	Bias (B)	Uncerta ±(B + 1	tainty t958)	Y
Farameter Designation	Percent of Reading	to tinU -eruzaeM taem	Degree of Freedom	Percent to Reading	lo finU -eruzseM finem	Percent to Reading	lo tinU -srusseM tnsm	Range
HEAT TRANSFER COEFFICIENT, H(TT), H(.915TT), Btu/ft2-sec- °R	2.0		30	2.0		6.0		
MACH NUMBER, M	0.38		30			0.76		3.9-4.0
WALL TEMPERATURE, TW, °F		1	30		2	4		A11
WEDGE ANGLE, WA, deg		0.05	30		ţ		0.10	A11
REYNOLDS NUMBER, RE	0.70		30	0.56		1.96		0.5x106
	0.36	•	30	0.45		1.17		3.7x10 ⁶ ft ⁻¹
					. •			
				1111		1 2 C 2 C 2 C 2 C 2 C 2 C 2 C 2 C 2 C 2	Week	1 0 0 0 0

"Handbook Uncertainty in Gas Turbine Measurements." *Reference: Abernethy, R. B. et al. and Thompson, J. W. AEDC-TR-73-5, February 1973 +Assumed to be zero

Table 8. Photographic Data Summary

ness erreralemental inversel inversel inversel inversel inversel inversel inverse inverse inverseliere S

Ü

17.5

\$32 XX

B

× × ×

477 SEE

556 (IB 626 RZC

	CAMERA TYPE	APPROX. FRAME RATE	CAMERA VIEW	FILM I.D.
Feasibility checkout	Varitron 70 mm sequence stills	l per run	Top view of oil flow on test article at centerline	Roll No. 938
	Television	Real time videotape	Top view of test article	NA
	Television	Real time videotape	Side view of test article	NA
	Television	Real time videotape	Shadowgrpah, fwd and aft	NA
Calibration and Material Evaluation	Varitron 70 mm sequence stills	l per run or l every 30 sec	Shadowgraph, aft	Roll Nos. 540, 546, 932
	Varitron 70 mm sequence stills	l per run or l every 30 sec	Schlieren, fwd	Roll Nos. 539, 545, 937
	DBM-55 motion picture	24 frames per sec	Forward onlooking test article	Reel Nos. 4637, 4738, 4639
	DBM-55 motion picture	400 frames per sec	Forward onlooking test article	Reel Nos. 4640-4643
	Bolex 16 mm motion picture	8 frames per sec	Infrared color video monitor	Reel No. 4644
	Varitron 70 mm sequence still	l every 4 sec	Infrared color video monitor	Roll Nos. 547, 548
Material Evaluation	Hasselblad 70 mm sequence stills	After each sample tested	Test article in tank	Roll No. 1

Table 9. Test Summary
a. Feasibility Checkout Phase

l l		PT,psia	TT,°F	WA, deg
1001	None	30	1440	0
1002				-2
1003				-4
1004				-6
1005				0
1006		. ↓		
1007		60		
1008		20		
1009	V [
1010*	Contour 1			
1011*	Contour 1	60		·
1012*	Contour 2 - Reclined	20		
1013*	Contour 2 - Reclined	30		
1014*	Contour 1			
1015	None	V	V	

^{*} Oil flow runs

200 mg/200 mg/20

が、 下次

Table 9. Continued b. Calibration Phase

RUN	PT,psia	TT,°F	WA,deg	TIME ON CENTERLINE (approx.),sec
2	30	318	0	14
3	1	329	0	11
4		254	0	28
5	. ♦	301	-4	23
6	25	318	0	29
9	4	340	-2	22
11	20	347	-4	23
12		349	-2	22
13		840	0	31
14			-4	23
15		•	-2	25
17		1440	-4	7
18			-2	9
19	•		0	8
20	25	1420	0	8
21		1440	-4	9
22	•	↓	-2	8

Table 9. Concluded c. Material Evaluation Phase

RUN	PT,psia	TT,°F	WA, deg	SAMPLE	EXPOSURE TIME (approx.),sec
23	20	180*	-2	A - Baseline	250
24	25	313	-2	A - Baseline	250
25	20	1440	0	Thermal Calibration Model	250
26	1	1315	1	!	93
27	₩	1215			250
28	25	1215		V	250
29	20	1115		B-Baseline TC to 100°F	94
30	20	975	V	F-STS-6 Blanket	106

^{*} The total temperature climbed approximately 6°F/minute throughout this run, and TT = 204°F at the time of model retraction.

Table 10. Summary of Data Acquisition and Tabular Print

E .

2000 0000

ので

Gardon Gage Data	
Data Acquisition (data taking rate)	Approx. every 0.1 sec
Tabular Printed Data	Data at 1 sec after centerline
Magnetic Tape	All recorded data
Thermocouple Data	
Data Acquisition (data taking rate)	Approx. every 0.1 sec for first 15 sec of run, then once every 2 sec (calibration) or 4 sec (Mat'l Evaluation)
Tabular Printed Data	Once every 2 sec (Calib.) or 4 sec (Mat'l Eval.) and also at camera firings
Magnetic Tape	All recorded data
Static Pressure Data	
Data Acquisition (data taking rate)	Same as for thermocouples
Tabular Printed Data	Data averaged over 5 consecutive readings 10-15 seconds after centerline as indicated on data
Magnetic Tape	All recorded data
Dynamic Pressure Data	
Data Acquisition	Continuously recorded on magnetic tape. RMS meter data read once same time as static pressure reduced.
Tabular Printed Data	One data reading per run for 15 rms measurements
Magnetic Tape	Raw signal
Infrared Data (using 8 deg lens)	
Digital Data	1 frame every 4 sec
Tabular Printed Data (final)	Assorted frames
Magnetic Tape	All recorded data
Photographic Data (Calib. and Mat'1 I	Eval. Phases)
Shadowgraph Stills	Nominally, 1 sec after centerline
Sequence Still Camera (photos of IR monitor)	1 every 4 sec
Motion Picture Camera (movies of IR monitor)	8 frames per sed
Motion Picture Camera (2) (movies of sample)	24 and 400 frames per sec

APPENDIX III

SAMPLE TABULATED DATA

ARVIN/CALSPAN FIELD SERVICES, INC. AEDC DIVISION VON MARNAN GAS DYNAMICS FACILITY ARNOLD ALM FORCE STATION, TENNESSEE MASA/MI 1145 POD AFRSI TEST

PUN 100

AND THE CONTRACT OF THE PROPERTY OF THE PROPER

. 1

というなん

'

7

in

7

12155144 27-MAY-83 19137151

PROJECT NUMBER V

FEASIBILITY CHECKOUT PHASE OHS MODEL! NONE

*** HEAT TRANSFER DATA ***

												2	TTUEND	4.5170
					ė	•								2,51
						<i>,</i> ·	•					430	7 DEG	6.93
												3		3.567E-07
ST(TT)	1.764E-03	1.626E-03	1.4015-03	1.2536-03	1.4405-03	4 4186-02	4515-01	4141.02	TAKE OF	1 2 4 4 4 C	1,378b-03	C #	LHM/FT3	1.145E-03
ď	,											>	FT/SEC	4245.1
H(TT) HTU/FT2-SEC-DEG-R	2.200E-03	2.027E-03	1.7471.03	1.5625-03	1.65#5-03	1.6425-03	1.804F=0.3	1.7668-03	1.724F-03	1.725E-03	1.717E-03	٠ م	PSF	320.64
HTU/F	•	••									-	þ	DEGR	4ex .5
ODUT RTU/FT2-SEC	2.958	2,742	2,358	2,111	2,241	2,214	2,445	2,381	2,334	2,332	2,316	۵.	PSIA	2.072E-01
TW DEGR												I	,	3,92
TG Degr	534.1	532.1	530.9	530.9	533.0	533.7	5 13.5	534.0	533.6	532.2	532.9	3	6 T = 3	4.238.405
× #	0.0	0	•	••	4.5	3.1	1.8	0.0	-1.8	-3.1	. t. s	ţ	DECR	7.5681
× =	7.50	00	10.50	17.00	13.50	13.50	13.50	14.50	13.50	13.50	13,50	-	PSIA	٠.,
CAGE NO.	- - (~	~	•	'n	•	_	#	•	9	Ξ	FUN		

Sample 1. Gardon Gage Data - Feasibility Checkout Entry

WEDGE ANGLE Deg

FLANGE/P118

FLANGE 0,123

80.0

0.59

F. V	, , , , , , , , , , , , , , , , , , ,	SSEE	
sek i cesti	ICS FACILIT	ARMULO AIM FORCE STATIOM, TENNESSEE NASA/HI DMS DOD AFRSI	,
Pr. 4120	GAS DYNAM	FORCE STA S POD AFRS	
AND DIVISION FIGUR SERVICES INC. 114	VUN KARAA	NASAZKI OM	PAGE 1

AND THE PROPERTY OF SECRETARY SECRETARY

THE PROPERTY OF THE PROPERTY O

2% C3

·	FLANGE/PIN 1.59
TIMECL SEC 9.75	MU LBF-SEC/FT2 1.535E-07
TIMERD SEC 10.86	RHD LBM/FT3 3.074E-03
	v FT/SEC 2660.1
POD ANGLE Deg 0.0	0 PSF 338.08
	T DEG F -269.0
Wedge angle Deg -0.05	P PSIA 2.172F-01
	3.93
Alpha angle Deg 10.05	RE FT-1 1.66E+06
	17 DEG F 318.0
CUNF	PT PSIA 30.0
	20 20 20 20 20 20 20 20 20 20 20 20 20 2

*
DATA
TRANSFER
HEAT
CALIBRATION
Pressure
*

ST(0.915 TT)	1.042E-03	1,115E-03	1.020E-03	8.941E-04	7.271E-04	4.770E-04	6.103E-04	1.020E-03	1.030E-03	1.2346-03	1,0495-03
H(0.915 TT)	2.048E-03	2.192E-03	2,004E-03	1.7576-03	1.4296-03	9.3745-04	1.593103	2.005E-03	2.024E-03	2,425E-03	2,0618:-03
ST(TT)	7.553E-04	8.0746-04	7,3938-04	6.492E-04	5.2796-04	3.463E-04	5.8788-04	7,396E-04	7.4648-04	8,9316-04	7,5915-04
(TI)H	1.4906-03	1.5935-03	1.458E-03	1,2816-03	1.4415-03	6.831E-04	1.159E-03	1.4598-03	1.4738-03	1.762E-03	1,4988-03
0007	3,6168-01	3.850F-01	3,540E-01	3.1224:-01	2.538F-01	1.064E-01	2.819E-01	3.543E-01	3.5718-01	4.258E-01	3.6195-01
TW (OFC R)	535.0	5.35.9	534,9	533,9	534.0	534.1	534.6	534.B	535.1	536.0	530.0
16E	533.2	533.4	533,5	532.6	532.9	532.8	533.4	533.4	533.8	533,9	533.8
` > [4.50	3,10	1.80	00.0	00.00	00.0	00.0	00.0	-1.80	-3.10	•4.50
X	13.50	13.50	13,50	7.50	00.6	10.50	12.00	13,50	13.50	13,50	13,50
CAGE	-	4	E F	+	S	4	T 7	.	o 1	710	T11

Gardon Gage Data - Calibration and Material Evaluation Entry Sample 2.

Ĭ
8
8
8
AEDC DIVISION AND

The state of the second by the second second

5-AUG-83 8119156 30:47

TIME COMPUTED TIME COMPUTED DATE RECORDED STIME RECORDED PROJECT NUMBER V

.

Ž,

V--C-3E

		CONF	. L.	~	ALPHA ANGLE Deg	27:	Wedge Angle Ofg	5	POD ANGLE DEG	3	TIMERO	8	TIMECL		
		1000	00		10.05		-0.05		•	•	10.8	و	9.75		
RUR		PT	1100		RE F-1	,	PSIA	7 DEG F	30	v FT/SEC		RHO LBM/FT3	MU LRF-SEC/FT2	FLANGE/PI	×
~		30.0	318	0.	1.66E+06	3.93	2.172E-01			2660			1.535E-07	1.59	
EVENT	PIC		C.S.T.		TIME	TIMEEXP					TK110	TK 114		TK124	
!	9	H	E Z	SEC	SEC	SEC	DEG F	DEG F	DEG F	DEG	DEG F	DEG F	DEG	DEG F	
		&	19 5.	7.378							81.	82.		82.	
	•	œ	19 5	9,537							82.	82.		82.	
		30	 50 70	1,753							82.	82.		82.	
		æ	20	3.910							82.	82.	,	82.	
8		&	20	890.9			.08	92.	82.		82.	82.	83.	82.	
		œ	50	7,175			•0R	82.	_		82.	82.		82.	
		æ	20	9.334			•08	82.	•	82.	82.	#2.	83.	82.	
	•	∞ `	20 1	1.549			•0 8	82.		82.	82.	#2.	83.	82.	
		æ	20 1.	3,707			•08	B2.		82.	82.	R2.	83.	82.	
3		Œ	20 15	4.814	0000		8 0.	#2.		82.	8.5.	82.	83.	82.	
		æ	20 1	5.874	1.06		•0#	82.		87.	82.	82.	83.	82.	
		æ	_	18.032	3.22		. 08	82.		82.	8.2°	82.	83.	82.	
		œ	20 · 20	20.248	5.43		0.8	82.	82.	82.	82.	82.	83.	82.	
		30		22,405	7.59		. 08	82,		82.	82.	82.	83.	83.	
ප්		•		24.563	9.75	4.28	• 0 8	H2.		83.	я2.	86.	H5.	84.	
•		œ		25,670	10.86	5.38	•08	82.		80.	83.	• 68	87.	85.	
		æ		27.827	13,01	7.54	. 08	82.		91.	84.	93.	91.	87.	
		œ	30 20	9.986	15.17	9.70	9 0 9	#2.		97.	86.	97.	95.	91.	
SHC	-	œ	20	1.094	.16,28	10.81	80.	82.		100.	87.	66	97.	92.	
		œ	20	2,201	17,39	11.91	.09	B2.		102.	.88	101	66	94.	
100		•	30 30	4,369	19.56	14.08	• 0 8	82.		108.	8 8	104.	103.	97.	

Thermocouple and Camera Data - Pressure Calibration Sample 3.

Volumental examinations of the proposition of the p

O

AL 200 (200 %)	73		15.50 Section 1			**	1. The state of th	<u> </u>	Constant	
ARVIN/CALSPAN [ELD SERVICES, INC. ARDC DIVISION	TELD	SERVICES	, INC.							
VON KARMAN GA	IS DYNAH	IICS FACT	LITY							
ARKOLD AIR FC	DRCE STA	ITION, TE	NESSEE.							
HASA/RI OMS F	OD AFRS	1.5								

	117:36 NCG-83 1 6:11
	UG-63 08:17:36 11-AUG-83 9: 6:11
ŗ	COMPUTED COMPUTED RECORDED RECORDED
7	DATE CO TIME CO DATE WE TIME RE

PETA DEG F FT=1	PETA DEG F FT-1 3.92 1.398F-01 5.09 PLC TIME TIMEEXP FT-1 3.92 1.398F-01 -5.1 1 5.70 2.60 177.5 157.5 157.6 5.1 2 10.06 6.95 177.2 157.2 157.6 6.00 2 10.06 17.7 4.66 317.2 100.4 45.5 293.5 157.6 6.00 3 14.05 11.05 11.05 11.05 11.05 100.4 9 558.4 6.00 2 10.06 6.95 11.05 11.05 11.05 11.00	PET TT FRE N PSTA DEG F FT-1		40 40 40 40 40 40 40 40 40 40 40 40 40 4	11 12 12 12 12 12 12 12 12 12 12 12 12 1	### ##################################	# # # # # # # # # # # # # # # # # # #	PESIA 3985-0 75 3 157-2 164.7	#- 85 6		, 	0.4	-4-0 -4-0 -4-0			
PEIA DEG F FT=1 RE N PEIA DEG F PSIA DEG F PSIA DEG F PSIA DEG F D	PEIA DEG F FT PEIA DEG F FT PEG TIME TIMEEXP TS 1 TS 2 1398F NO. 5EC 5EC 5EC 5EC 5EC FT 1 7.77 4.66 179.5 191.4 456.5 197.2 187.6 187.6 19.0 17.2 191.4 456.5 197.2 187.6 19.0 17.2 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0	PEGA DEG F FT=1	TA THE THE THE TA	40	25.00 11.03 12.05 13.05 13.05 13.05 14.05 15.05	### ##################################	7	PSIA 398E-0 75 3 DEG F 157.2	# # 996 **							
PIC TIME THEER FTT FTT PS PS PS PS PS PS PS	PIC TIME THEER PTT PTT PEG PEG	PIC TIME THEEXP FT 1 PEG P 185 195 187 185 4 4 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	TO HH C M 4	40. 40. 40. 40. 40. 40. 40. 40.	25.05 10	# # # # # # # # # # # # # # # # # # #	2 2 2 2 2 2 2 2 3 2 3 2 3 2 3 2 3 2 3 2	PSIA 3985-0 78 3 DEG F 157-2			•		>	V	V	V RHO MU
PIC TIME TIMEEXP IS 1 TS 2 TS 3 TE 4	PIC TIME FINEEXP TS 1 TS 2 TS 3 TS 4 155.5 157.2 157.2 157.6 157.5 157.5 157.2 157.5	PIC TIME TIMEEXP TS 1 TS 2 TS 3 TS 4	00 HH 0 W 4	6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	·	######################################		TS 3 DEG F 157.2 164.7	-5.1	215	. 6.	FF FT/SEC. 92 4092.1	FT/SEC 4092.1 8	FT/SEC LBM/FT3 4092.1 8.297E-04	FT/SEC LBM/FT3 4092.1 8.297E-04	FT/SEC 1.8M/FT3 LB 4092.1 8.297E-04 3
MO. SEC SFC DEG F DEG F DEG F DEG F DEG F OF CO. 0.00	NO. SEC SFC DFG F	NO. SEC. NO. SEC. 154.4 155.5 157.2 164.4 157.2 164.7 154.4 155.5 167.5 164.7 154.4 155.5 167.5 164.7 154.4 155.5 167.5 164.7 154.4 157.5 164.7 157.2 164.7 157.2 164.7 157.2 164.7 157.2 164.7 167.5 167.		000 - 100 -	0 4850	######################################		DEG F 157.2 164.7	15 4	TS 5		TS 6	ø	6 75 7	6 75 7	6 TS 7 TS 8 TS
4.02 4.02 1.55.5 1.57.5 1.6.00 8.11 5.00 1.7.7 4.66 1.7.2 1.6.00 6.15 1.6.	4.02 4.02 1.55.5 1.55.5 1.777 4.66 1.775 2.10.06 1.777 4.66 3.17.2 3.14.2 3.14.2 3.14.2 3.14.2 4.18.6	4 602	N M	0 10 10 10 10 10 10 10 10 10 10 10 10 10	48500000000	4 10 10 10 10 10 10 10 10 10 10 10 10 10		157.2	DEG F	DEG		930	0 FG F 0	DEG F DEG F	DEG F DEG F	DEG F DEG F DEG F C
10.00	10.00	2 10.00 10.0	N M -	20000000000000000000000000000000000000	4848484848	11 M M M M M M M M M M M M M M M M M M		10401	5	158.1		V41	V41	149.1 159.3	149.1 159.3 157.9	144.1 159.3 157.9 154.8
7.77 4.60 317.2 381.1 682.6 517.0 51	7.77 4.66 337.2 404.0 708.9 558.4 17.1 5.00 337.2 404.0 708.9 558.4 17.1 5.00 337.2 404.0 708.9 558.4 17.1 5.00 337.2 404.0 708.9 558.4 16.15 13.05 60.7 744.2 948.9 824.3 690.9 14.2 11.05 13.05 656.2 948.9 825.7 785.0 744.2 948.9 853.7 77.0 744.2 948.9 853.7 77.0 744.2 948.9 775.4 77.0 775.4 840.7 1004.8 926.4 775.4 775.4 840.7 1004.8 926.4 775.6 775.6 934.1 1004.8 926.4 775.6 775.6 934.1 1055.6 1013.5 968.4 777.7 77	7.77 4.66 337.2 404.0 708.9 538.4 17.2 381.1 17.12 9.02 531.0 17.12 9.02 9.02 9.02 9.02 9.02 9.02 9.02 9.0	1 M M 4		480 6 8 4 8 8 6 9 6 6			756	104.1	2000		155.2	7.	100.9 ر 1 مرد د	.2 105.9 161.5 .2 27.4 7 210.1	.2 166.9 161.3 162.6 1
8.11 5.00 337.2 404.0 708.9 558.4 11.12 5.00 337.2 404.0 708.9 624.3 690.9 11.12 11.18 607.9 744.2 940.2 786.0 940.0 940.2 786.0 940.2 940	8.11 5.00 337.2 404.0 708.9 558.4 12.12 9.02 555.9 465.2 404.0 708.9 558.4 14.29 11.18 607.0 744.2 948.9 824.3 690.9 16.15 13.05 655.2 955.2 900.2 786.0 9 824.3 690.9 16.15 13.05 657.4 796.3 976.3 976.3 976.3 976.3 725.4 701.3 840.7 1004.8 926.9 925.9 17.05 72.4 701.3 840.7 1004.8 926.9 925.9 17.05 72.2 10.17.7 943.4 725.4 867.5 1017.7 943.4 725.4 867.5 1017.7 943.4 725.4 867.5 1017.7 943.4 725.9 72.9 1043.3 704.9 976.5 1017.7 943.4 725.9 725.9 1043.3 704.0 976.5 1017.7 943.4 976.5 1017.7 943.4 976.5 1017.7 943.4 976.5 1017.7 943.4 976.5 1017.7 943.4 976.5 1017.7 943.4 1010.4 97.7 943.4 1077.2 1017.8 97.7 97.8 97.8 958.4 1077.2 1017.3 1077.2 107	8.11 5.00 337.2 404.0 708.9 558.4 11.05.0 535.9 550.9 824.3 690.9 31.2 16.15 13.05 11.18 607.0 744.2 948.9 11.18 607.0 744.2 948.9 11.18 607.0 744.2 948.9 823.7 725.4 19.83 755.9 945.3 1004.8 926.9 72.9 1017.7 943.4 775.9 875.5 1017.7 943.4 777 777 777.9 875.9 938.3 1055.6 1033.5 958.4 777 777 777 777 777 777 777 777 777 7	. M M 4	22222222222222222222222222222222222222	8 6 8 8 8 8 6 8 6 8	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		682.6	531.0	5.628		553.5	110	. 4	5 464.6	.5 464.6 415.3 468.1
2 16.06 6.95 555.9 656.2 900.2 786.0 9 12.12 9.02 535.9 656.2 900.2 786.0 9.02 11.18 667.0 744.2 948.9 853.7 16.15 13.05 654.4 796.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.4 976.5 1017.7 943.4 778.9 912.9 912.9 1043.3 976.6 976.6 27.28 24.17 790.4 921.2 1044.4 976.6 27.28 27.28 87.17 790.4 921.2 1044.4 945.0 948.7 791.5 20.5 8 821.0 949.7 1063.3 1006.6 933.7 31.65 24.2 958.4 1070.1 1010.4 94.0 18 37.07 818.0 959.6 1077.2 1017.3 1016.4 94.0 18 37.07 818.0 959.6 1077.2 1072.1 1072.	2 10.06 6.95 535.9 656.2 900.2 746.0 3 14.29 11.18 657.0 744.2 948.9 853.7 746.0 744.2 948.9 853.7 746.0 744.2 948.9 853.7 756.4 796.3 976.3 976.3 893.8 693.8 22.94 19.83 756.9 976.5 1017.7 943.4 756.9 976.5 1017.7 943.4 756.9 972.9 1043.5 968.6 27.28 27.28 27.17 778.9 972.9 1043.5 968.6 27.28 27.17 778.9 972.9 1043.3 976.6 1017.7 948.7 7 976.4 971.2 1049.4 976.6 1017.5 978.7 31.56 28.8 805.2 934.1 1059.6 1010.6 93.3 37.77 34.6 812.9 948.3 1059.6 1010.6 949.7 1063.3 1010.6 940.18 37.07 813.1 959.6 1077.2 1010.4 940.18 37.07 813.1 959.6 1077.2 1010.4 970.1 977.3 1075.4 1072.5 1072.1 1075.4 10.2 57.45 54.29 864.3 987.1 1087.3 1075.8 1075.4 1077.2 1077.2 1077.2 1077.2 1077.3 1075.8 1077.4	2 10.06 6.95 445.5 550.9 824.3 600.9 3 14.29 11.18 6.07.0 744.2 940.2 786.0 785.2 56.15 13.05 6.54.4 796.3 976.3 976.3 883.7 17.06 754.4 796.3 976.3 976.3 883.7 17.06 755.9 895.6 1033.5 968.6 27.28 22.94 19.83 776.9 895.6 1033.5 968.6 776.6 27.28 22.47 700.4 895.6 1033.5 968.6 776.6 27.28 22.74 778.9 9712.9 1043.3 976.6 776.6 27.28 22.74 778.9 9712.9 1043.3 976.6 776.6 812.9 9712.9 1043.3 1005.6 1003.5 968.6 776.6 976.6 976.6 976.6 976.6 976.7 1005.6 976.6 976.6 976.7 1005.6 976.6	0 m 4	110.00 112.12 112.12 112.12 122.12 123.13 12		4 N 5 S S S S S S S S S S S S S S S S S S		33	558.4	559.5		582.4	4	4 489.8	8.044 A.004 A.	4.894 E.BAA 8.984 A.
12.12 9.02 535.9 656.2 900.2 786.0 3 14.29 11.18 667.0 744.2 948.9 853.7 16.15 13.05 654.4 796.3 976.3 976.3 893.8 670.17 17.06 725.4 867.5 1017.7 976.9 875.0 27.28 27.28 27.28 27.28 27.28 10.43.5 976.6 976.6 27.28 27.28 27.28 10.43.5 976.6 976.6 27.28 27.28 27.29 892.2 10.49.4 945.0 29.69 20.58 805.2 934.1 10.55.6 9976.0 33.79 30.68 82.8 921.2 10.69.9 10.10.4 945.7 10.10.4 940.7 10.10.4 975.0 10.10.4 976.0 976.0 10.10.4 976.0 976.0 10.10.4 976.0 976.0 10.10.4 976.0 976.0 10.10.4 976.0 976.0 10.10.4 10.10.4 975.0 10.12.5 10.10.4 975.0 10.12.5 10.12.1 1	3 14.29 11.18 6677.0 744.2 900.2 746.0 3 14.29 11.18 6677.0 744.2 948.9 853.7 15.18 15.54 701.1 840.7 1004.8 976.3 976.3 976.6 15.54 19.83 756.9 976.3 976.8 976.9 976.0	3 14.29 11.18 6677.0 744.2 900.2 746.0 3 14.29 11.18 6677.0 744.2 948.9 853.7 15.18 15.54 701.1 840.7 1004.8 926.9 853.7 20.17 17.05 945.9 945.5 1017.7 943.8 926.9 926.	m +	22 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	21222222	6 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5		824.3	6.069	697.9		713.1	11 607	,1 607.1	1 607.1 577.1	1 607.1 577.1 622.6 5
3 14.29 11.18 607.0 744.2 948.9 853.7 16.15 13.05 654.4 796.3 978.3 893.8 18.64 15.54 701.1 840.7 1004.8 926.9 920.17 17.06 725.4 867.5 1017.7 943.4 22.94 19.83 756.9 912.9 1043.3 968.6 27.28 27.28 27.47 778.9 912.2 1049.4 945.0 29.69 20.58 805.2 934.1 1055.6 968.6 27.28 27.28 27.79 805.2 934.1 1055.6 1002.6 1002.6 33.79 30.68 821.0 949.7 1063.3 1006.6 1002.6 37.77 34.66 822.9 938.3 1055.6 1002.6 1010.6 940.18 37.07 838.0 958.4 1070.1 1010.4 940.18 37.07 838.0 958.4 1070.1 1010.4 940.18 37.07 838.0 959.6 1072.2 1072.1 1040.9 940.18 37.07 838.0 959.6 1072.2 1072.1	3 14.29 11.18 607.0 744.2 948.9 853.7 16.15 13.05 654.4 796.3 976.3 863.8 618.64 18.54 701.1 840.7 1004.8 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.3 976.5 1017.7 943.4 756.9 895.6 1033.5 968.6 727.28 27.28 27.28 1043.3 976.0 976.0 972.2 1043.3 976.0 976.0 972.2 1043.3 976.0 976.0 972.2 1043.3 976.0 976.0 978.3 10.56.0 977.2 1010.4 976.0 976.0 977.2 1072.7	3 14.29 11.18 607.0 744.2 948.9 853.7 16.15 13.05 654.4 796.3 978.3 893.8 14.29 11.18 607.0 744.2 948.9 853.7 20.17 17.06 725.4 867.5 1017.7 943.4 225.58 22.94 19.83 756.9 895.6 1033.5 968.6 43.4 225.58 27.28 27.28 27.17 790.4 9212.9 1043.3 976.6 22.58 27.28 27.17 790.4 9212.9 1043.3 976.6 22.58 805.2 934.1 1055.6 9968.7 7 31.56 28.46 812.9 934.1 1055.6 9968.7 37.7 34.66 822.8 958.4 1070.1 1010.6 940.1 37.3 34.72 833.1 959.6 1063.3 1010.6 940.1 1010.6 940.	m +	22 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	10000000000000000000000000000000000000	654.0 701.1 725.1 756.9		2.006	786.0	793.H		799.1	,1 695	,1 695,1	,1 695,1 675,8	,1 695,1 675,8 713,1
16.15 13.05 654.4 796.3 978.3 893.8 18.64 15.54 701.1 840.7 1004.8 926.9 926.9 20.17 17.06 725.4 867.5 1017.7 943.4 25.59 19.83 756.9 812.9 1043.3 947.6 27.28 24.1 778.9 912.9 1043.3 947.6 22.94 24.1 7 790.4 921.2 1049.4 945.0 29.69 20.58 805.2 934.1 1055.6 997.0 949.7 1063.3 1006.5 93.79 30.68 822.9 938.3 1055.6 1002.5 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1006.5 940.7 1063.3 1072.5 1017.1 14.99 34.9 940.8 954.8 1059.9 1016.4 96.09 44.51 41.40 846.0 964.0 1077.2 1077.2 1072.7 14.99 847.0 854.2 972.5 1067.2 1072.7 1072.7 12.5 12.5 14.5 54.29 854.2 972.5 1067.4 1075.8 11.5 54.29 51.18 854.6 987.1 1087.3 1030.4 12.5 84.5 54.29 51.18 854.6 987.1 1087.3 1030.4 12.5 84.5 54.29 51.18 854.6 987.1 1087.3 1030.4 12.5 84.5 54.29 51.18 854.6 987.1 1087.3 1030.4 12.5 84.5 54.29 51.18 854.6 987.1 1087.3 1030.4 12.5 84.5 54.29 51.18 854.6 987.1 1087.3 1030.4 12.5 84.5 54.5 54.5 54.5 54.5 54.5 54.5 54	16.15 13.05 4 18.64 18.54 196.3 196.3 196.4 19.68 19.554 19.68 20.17 17.06 17.554 19.55 1017.7 19.35 25.58 27.28 27.39 27.30 2	16.15 13.05 654.4 796.3 976.3 893.8 18.64 18.64 15.54 701.3 840.7 1004.8 926.9 926.9 20.17 17.06 725.4 867.5 1017.7 968.6 725.9 895.6 1033.5 968.6 22.94 19.83 756.9 895.6 1033.5 968.6 22.94 24.17 790.4 921.2 1049.4 945.0 22.58 24.27 790.4 921.2 1049.4 945.0 33.79 30.68 821.0 949.7 1053.3 4976.6 921.0 949.7 1053.3 1006.6 93.3 37.77 34.66 821.0 949.7 1063.3 1006.6 93.77 34.66 821.0 949.7 1063.3 1006.6 940.7 1063.3 1006.6 940.7 1063.3 1006.6 940.7 1007.2 1017.5 940.9 940.7 1072.2 1017.5 940.9 940.7 1072.2 1017.5 940.0 950.1 977.2 1077.3 1077.2 1	•	20 14 22 24 25 25 26 25 26 26 26 26 26 26 26 26 26 26 26 26 26	22.6.0	654.4 701.1 725.4 756.9		948.9	853.7	856.4		855.1	1 761	1 761.2	,1 761.2 749.3	1 761.2 749.3 778.5
4 18.64 15.54 701.1 840.7 1004.8 926.9 20.17 17.06 725.4 867.5 1017.7 943.4 25.58 27.94 19.83 756.9 895.6 1033.5 968.6 27.28 27.28 27.28 27.28 27.28 27.29 1043.3 947.6 27.28 27.28 27.28 27.29 1043.3 947.6 27.28 27.28 27.28 27.2 1049.4 945.0 29.69 20.69	4 18.64 15.54 701.1 840.7 1004.8 926.9 20.17 17.06 725.4 867.5 1017.7 943.4 25.58 25.58 25.54 756.9 895.6 1033.5 968.6 27.28 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.29 1043.3 1049.4 975.0 1049.4 975.0 1049.4 975.0 1072.6 1072.6 1072.6 1072.6 1072.6 1072.6 1072.6 1072.6 1072.6 1072.6 1072.6 1072.7 1044.5 10.4 45.72 833.1 959.6 1077.2 1077.3 1075.4 11.49 874.6 967.6 1077.2 1077.3 1072.7 11.48 874.6 967.6 1077.2 1077.3 1072.7 11.5 51.28 854.2 972.5 1065.7 1072.7 11.5 51.28 854.2 972.5 1065.7 1075.8 11.5 51.28 54.2 972.5 1087.3 1031.6 11.8 57.45 55.34 874.4 986.3 3 987.1 1087.3 1031.4 11.8 57.45 55.34 874.4 986.2 1087.3 1031.4 11.8 57.45 55.34 874.4 986.2 1087.3 1031.4 11.8 57.45 55.34 874.4 986.2 1087.3 1031.4 11.8 57.45 55.34 874.4 986.7 1031.4 1031.	# 18.64 15.54 701.1 R40.7 1004.8 926.9 20.17 17.06 725.4 R67.5 1017.7 943.4 25.58 25.58 25.54 776.9 895.6 1033.5 968.6 27.28 27.28 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.29 938.3 1055.6 995.0 10102.6 33.79 37.77 34.66 822.8 958.4 1077.0 1010.4 37.77 34.66 832.8 958.4 1077.0 1010.4 37.77 34.66 959.6 1072.2 1010.4 41.99 38.38 37.07 838.3 1059.6 1072.2 1010.4 41.99 38.88 854.2 957.6 1077.2 1072.3 1075.4 11.48 854.2 972.5 1087.2 1072.7 11.2 53.12 50.19 855.6 983.7 1085.7 1075.8 11.2 53.0 18 855.6 983.7 1085.7 1075.8 11.2 57.45 55.34 863.3 987.1 1087.3 1031.4 11.4 558.5 55.34 864.6 1086.2 1087.3 1031.4 11.4 558.6 59.8 863.3 987.1 1087.3 1031.4 11.4 558.5 55.34 864.2 987.1 1087.3 1031.4 11.4 558.5 55.34 864.2 987.1 1087.3 1031.4 11.4 558.6 55.34 866.8 969.3 1090.5 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031.4 11.3 1031	•	20.17 22.94 22.558 27.28 29.69	2.00	701.1 725.4 736.9	•	976.3	893.8	893.7		BH7.4	~ •	802.8	4 802.8 743.9	4 802.8 793.9 H15.9
20.17 17.00 725.4 Hb7.5 1017.7 943.4 25.294 19.83 756.9 H95.6 1033.5 968.6 27.28 27.28 27.29 1043.3 946.6 27.28 27.28 27.29 1043.3 946.6 27.28 27.28 24.1 7 790.4 921.2 1049.4 945.0 29.69 20.58 805.2 934.1 1055.6 998.7 31.56 24.29 938.3 1055.6 1002.6 1002.6 33.79 30.68 821.0 949.7 1063.3 1006.6 1002.6 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 832.8 958.4 1070.1 1010.4 9 40.18 37.07 838.0 958.4 1070.1 1010.4 9 40.18 37.07 838.0 958.6 1072.2 1012.1 104.9 34.90 34.60 961.3 1077.2 1021.3 14.40 846.0 967.6 1077.2 1021.3 14.40 853.1 975.3 1081.1 1022.7 11.5 53.12 50.19 854.2 972.5 1065.7 1026.6 13 57.45 54.29 51.18 854.6 987.1 1081.3 1030.4 11.5 57.45 54.29 51.18 854.6 987.1 1081.3 1030.4 11.5 58.8 55.8 55.3 56.3 56.3 56.5 56.5 56.5 56.5 56.5	20.17 17.00 725.4 Hb7.5 1017.7 943.4 25.294 19.83 756.9 H95.6 1033.5 968.6 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.28 27.29 1043.3 976.6 27.28 27.28 27.29 1043.3 1049.4 945.0 33.79 30.68 821.0 949.7 1063.3 1002.6 1002.6 37.77 34.68 821.0 949.7 1063.3 1006.6 1002.6 37.77 34.68 832.8 958.4 1070.1 1010.4 37.77 34.06 833.1 959.6 1072.2 1012.5 41.99 34.99 34.00 959.6 1072.2 1012.1 1010.4 44.51 41.40 846.0 961.3 1077.2 1071.3 14.40 853.1 975.3 1081.1 1072.7 11.2 53.12 53.12 50.19 854.2 972.5 1065.7 1075.8 12 53.15 54.35 863.3 987.1 1081.3 1031.6 13.5 57.45 55.34 864.4 986.2 1087.3 1031.6 131.	20.17 17.00 725.4 Hb7.5 1017.7 943.4 25.294 19.83 756.9 H95.6 1033.5 968.6 27.28 27.28 27.29 1043.3 946.6 27.29 27.29 1043.3 946.6 27.29 27.29 24.1 790.4 921.2 1049.4 945.0 29.69 20.58 805.2 934.1 1055.6 1002.6 33.79 30.68 821.0 949.7 1063.3 1006.6 1002.6 37.77 34.68 822.9 951.3 1057.0 1010.4 37.77 34.06 832.8 958.4 1070.1 1010.4 37.77 34.06 833.1 959.6 1072.2 1012.5 41.99 38.88 958.6 1072.2 1012.5 10.6.09 44.51 41.40 846.0 961.3 1077.2 1072.3 1075.4 11.40 854.2 975.3 1081.1 1072.7 11.2 53.12 50.19 855.6 1075.3 1081.1 1072.7 11.75.8 15.745 55.34 863.3 987.1 1087.3 1031.4 11.4 558.45 55.34 864.2 987.1 1087.3 1031.4 11.4 558.6 948.6 1078.3 1091.3 4.1 1087.3 1031.4 11.4 558.45 969.3 1090.5 1031.4 11.4 11.4 11.4 11.4 11.4 11.4 11.4		22 25 24 27 27 28 27 28 28 29 29 29 29 29 29 29 29 29 29 29 29 29	22.4	725.4 756.9	•	1004.8	926.9	924.5		914.7		.7 643.1	.7 843.1 835.7	.7 843.1 835.7 852.9
5 22.44 19.83 756.9 895.6 1033.5 968.7 25.56 27.28 27.24 7 778.9 912.9 1043.3 976.6 29.69 27.28 27.28 27.28 27.29 27.29 1043.3 976.6 29.69 20.58 805.2 934.1 1055.6 1002.6 33.79 30.68 8212.9 938.3 1055.6 1002.6 1002.6 37.77 34.66 8212.9 949.7 1063.3 1006.6 1072.6 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 833.1 959.6 1070.1 1010.4 41.99 31.90 31.90 959.6 1072.2 1012.1 104.90 31.90 31.90 959.6 1077.2 1072.1 1072.1 104.90 44.51 41.40 846.0 961.3 1077.2 1071.3 1072.7 107	5 22.44 19.83 756.9 895.6 1033.5 968.7 25.56 27.28 27.28 27.24 7 778.9 912.9 1043.3 976.6 27.28 27.28 27.28 27.29 1043.3 976.6 29.69 20.55 805.2 934.1 1055.6 1002.6 33.79 30.68 8212.9 938.3 1055.6 1002.6 1002.6 33.79 30.68 8212.9 938.3 1055.6 1002.6 1002.6 37.77 34.66 8212.9 949.7 1063.3 1006.6 940.7 1063.3 1006.6 940.7 1063.3 1006.6 940.18 37.07 838.0 958.4 1070.1 1010.4 940.18 37.07 838.0 958.4 1070.1 1010.4 940.18 37.07 838.0 959.6 1072.2 1012.1 110.2 940.1 1077.2 1072.1 110.2 940.0 961.3 1047.2 1072.7 11072.7	5 22.94 19.83 756.9 895.6 1033.5 968.7 25.56 27.28 27.28 27.28 27.29 892.2 1049.4 945.0 29.69 27.28 27.28 27.28 27.28 27.29 27.29 1043.3 976.6 29.69 20.58 805.2 934.1 1055.6 1002.6 33.79 30.79 827.2 1049.4 1055.6 1002.6 33.79 37.77 34.66 827.2 951.3 1057.0 1010.6 5 37.77 34.66 827.2 951.3 1057.0 1010.6 5 37.77 34.66 827.8 958.4 1070.1 1010.4 37.77 34.66 951.3 1070.1 1010.4 41.99 37.07 838.0 958.4 1070.1 1010.4 41.99 37.07 838.0 958.6 1072.2 1012.5 1057.3 1044.5 1077.2 1072.1 11072.	,	22.44 25.58 27.28 29.69	× -	156.9	•	1017.7	443.4	430.4		?	مو:	.6 862.1 854.	.6 862.1 854.6	.6 862.1 854.6 868.3.
25.58 27.28 27.47 790.4 972.9 1043.3 347.0 27.28 27.28 27.28 27.28 27.29 27.2 1049.4 945.0 29.69 27.28 27.28 27.29 821.2 1049.4 948.7 1055.6 1002.6 33.79 33.79 30.68 821.0 949.7 1053.3 1005.6 1002.6 37.77 34.66 832.8 958.4 1077.0 1010.4 37.77 34.66 833.1 959.6 1070.1 1010.4 41.99 34.72 838.1 959.6 1072.2 1012.5 41.99 34.90 848.6 951.3 1074.0 1077.2 1072.3 14.40 846.0 961.3 1077.2 1077.3 1072.7 11.48.84 45.74 853.1 975.3 1081.1 1072.7 11.25.12 53.12 50.19 854.2 972.5 1065.4 1074.6 1076.5 11.31.6 13.57.45 54.29 51.18 854.5 947.1 1081.3 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 11.58.8 1030.4 103	27.28 27.24 77.84 912.9 1043.3 1043.3 17.28 27.28 27.28 27.28 27.28 27.28 27.29 21.2 1049.4 945.0 29.69 25.58 805.2 934.1 1055.6 1002.6 33.79 31.56 24.29 934.1 1055.6 1002.6 1002.6 33.79 34.72 828.2 951.3 1057.0 1010.4 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 833.1 959.6 1072.2 1012.5 10.69.9 1016.4 41.99 34.72 838.0 958.4 1070.1 1010.4 41.99 34.88 846.0 961.3 1074.0 1071.3 10.69.9 1016.4 86.09 42.98 854.2 972.5 1081.1 1022.7 11.2 53.12 53.12 53.1 975.3 1081.1 1072.7 11.2 53.15 54.29 51.18 855.6 987.6 1006.5 1031.6 11.2 57.45 55.34 86.3.3 987.1 1081.3 1031.4 11.3 57.45 55.34 86.3.3 987.1 1081.3 1031.4 11.3 1031.4	25.58 27.28 27.47 790.4 972.9 1043.3 347.0 27.28 27.28 27.28 27.28 27.28 27.29 27.2 1049.4 945.0 29.69 25.58 805.2 934.1 1055.6 1002.6 33.79 31.56 24.6 821.0 949.7 1063.3 1005.6 1002.6 37.77 34.66 822.8 958.4 1077.0 1010.4 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 833.1 959.6 1072.2 1012.5 10.6 14.99 34.90 959.6 1072.2 1012.5 10.6 10.6 10.6 10.6 10.6 10.6 10.6 10.6	n	27.78 27.78 29.69	* -		895.6	1033.5	968.8	957.4		943.7		E # # 2	9.61.8 8.49.6	S. S
29.69 20.58 805.2 934.1 1055.6 1012.0 33.79 34.5 1055.6 1012.0 33.79 30.68 821.0 949.7 1055.6 1010.0	29.69 20.58 29.69 20.58 29.69 20.58 31.56 20.68 31.79 31.70 818.0 958.4 1070.1 1010.4 940.18 31.70 818.0 958.4 1070.1 1010.4 11.40 846.0 961.3 1072.2 1012.1 1016.4 11.40 846.0 961.3 1077.2 1071.3 1072.7 117	29.69 29.69 20.58 805.2 934.1 1055.6 1002.6 33.79 30.68 821.0 949.7 1063.3 1006.6 83.79 940.7 1006.6 938.2 951.3 1006.6 937.77 34.02 938.3 1005.6 1002.6 938.2 951.3 1006.6 940.7 1006.7	•	29.63	7		912.9	1043.3	9.419.00	× 0/6		955.I	955.1	7.504 1.	902 7 700 0	. 405.7 896.6 905.4
7 31.56 28.46 812.9 938.3 1059.6 1002.6 33.79 30.68. 8212.9 938.3 1059.6 1002.6 33.79 30.68. 8212.0 949.7 1063.3 1006.6 5 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 833.1 959.6 1070.2 1010.4 41.99 318.88 848.0 959.6 1072.2 1012.1 10 44.51 41.40 846.0 961.3 1074.0 1077.2 1021.3 14 46.09 47.08 848.6 967.6 1078.3 1022.7 11 50.19 47.08 854.2 972.5 1067.4 1024.6 13 57.45 54.29 51.18 854.5 983.7 1085.7 1025.8 13 57.45 54.29 51.18 856.6 1087.3 1081.3 1030.4 11 1	7 31.56 28.46 812.9 938.3 1059.6 1002.6 33.79 33.79 30.68. 821.0 949.7 1063.3 1006.6 1002.6 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 833.1 959.6 1070.1 1010.4 41.99 318.8 840.8 951.3 1070.1 1010.4 41.99 318.8 840.8 961.3 1074.0 1071.3 1044.0 1077.2 1072.1 1046.0 961.3 1077.2 1072.1 1072.7 1070.1 1072.7 1072.8 1072.7 1072	7 31.56 28.46 812.9 938.3 1059.6 1002.6 33.79 33.79 34.75 828.2 951.3 1057.0 1012.5 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 833.1 959.6 1070.1 1010.4 41.99 38.00 959.6 1072.2 1012.1 10.44.51 41.40 846.0 961.3 1074.0 1077.2 1072.1 10.5 46.09 44.51 41.40 846.0 961.3 1077.2 1071.3 10.5 46.09 47.08 854.2 972.5 1087.2 1022.7 11.2 54.29 51.18 854.2 972.5 1085.4 1075.8 11.2 54.29 51.18 856.6 987.6 1086.5 1031.6 11.5 57.45 55.34 863.3 987.1 1087.3 1031.4 11.4 558.5 55.34 864.5 1096.5 1031.4 11.3 57.45 55.34 864.5 1096.5 1031.4 11.3 57.45 55.34 864.5 1096.5 1031.4 11.3 57.45 55.34 864.5 1096.5 1031.4 11.3 57.45 55.34 864.5 1096.5 1031.4 11.3 57.45 55.34 864.5 1096.5 1031.4 11.3 57.45 56.45 864.5 1096.5 1031.4 11.3 57.45 56.45 864.5 1096.5 1031.4 11.3 57.45 56.45 864.5 1096.5 1031.4 11.3 57.45 56.45 864.5 1096.5 1031.4 11.3 57.45 56.45 864.5 10.3 57.45 10.3 57.3 57.45 10.3 57.45 10.3 57.45 10.3 57.3 57.45 10.3 57.3 57.45 10.3 57.3 57.45 10.3 57.3 57.45 10.3 57.3 57.45 10.3 57.3 57.45 10.3 57.3 57.3 57.45 10.3 57.3 57.3 57.45 10.3 57.3 57.3 57.3 57.3 57.3 57.3 57.3 57	Þ	, n	¥	* C S C C	7.176	****	0000			6.00K		. 4 414.0 403.	2 2 2 4 4 5 4 5 5 4 5 5 4 5 5 5 5 5 5 5	10716 10716 0 11716 0 10716 0 10716 0 1071
33.79 30.68 821.0 949.7 1063.3 1006.6 3 35.70 37.79 828.2 951.3 1077.0 1012.5 37.77 34.66 832.8 958.4 1070.1 1010.4 37.77 34.66 832.8 958.4 1070.1 1010.4 41.99 37.07 838.0 959.6 1072.2 1015.1 10 44.51 41.40 846.0 961.3 1074.0 1077.2 1077.3 1046.0 967.6 1077.2 1077.3 1075.4 11 48.84 45.74 853.1 975.3 1081.1 1072.7 11 55.12 50.19 854.2 972.5 1065.4 1074.6 1076.3 1075.8 11 57.45 54.29 51.18 854.5 983.7 1065.7 1075.8 11 57.45 54.29 51.18 858.6 987.1 1081.3 1030.4 11 1087.3 1030.4 1	33.79 30.68 821.0 949.7 1063.3 1010.65 33.79 30.79 822.0 949.7 1063.3 1010.65 33.79 37.77 34.66 832.8 958.4 1070.1 1010.4 37.72 838.0 958.4 1070.1 1010.4 41.99 31.02 959.6 1072.2 1010.4 41.99 31.40 846.0 959.6 1072.2 1010.1 1007.0 1071.3 11.48.8 846.0 961.3 1077.2 1071.3 11.48.8 45.74 853.1 975.3 1081.1 1072.7 11.2 53.12 50.19 854.2 972.5 1067.4 1024.6 13.3 57.45 554.35 863.3 987.1 1087.3 1031.6 13.5 57.45 554.35 863.3 987.1 1087.3 1030.4 11.032.4 1031.6 13.3 57.45 556.3 486.4 986.2 1089.2 1037.4 11.3 57.45 556.3 486.4 986.2 1089.2 1037.4 11.3 57.45 556.3 486.4 986.2 1089.2 1037.4 11.3 57.4 56.4 56.4 56.4 56.4 56.4 56.4 56.4 56	33.79 30.68 821.0 949.7 1063.3 1006.6 33.79 30.79 828.2 951.3 1007.0 1010.4 37.77 34.06 832.8 958.4 1070.1 1010.4 37.77 34.06 833.1 959.8 1009.9 1016.4 9 40.18 37.07 838.0 958.4 1070.1 1010.4 10.99 31.09 31.40 846.0 961.3 1074.0 1071.3 1 1072.7 1 107.0 1077.2 1072.3 1072.7 107.0 1077.2 1072.7 1 1 2 53.12 50.19 854.2 972.5 1067.4 1075.8 1 1 2 53.12 50.01 859.5 983.7 1085.7 1075.8 1 1 57.45 55.34 864.4 986.2 1089.2 1031.4 1 1087.3 1031.4 1 1 58.55 56.55 865.8 1059.3 1090.5 1031.4 1 1037	•		E 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	7.000	7 0 7 0			967		V 00 V	7 020 6 020	7 070 E	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3 520 C 500 C 500 E
8 35.90 32.79 828.2 951.3 1067.0 1012.5 37.77 34.66 832.8 958.4 1070.1 1010.4 37.83 34.72 838.0 958.4 1070.1 1010.4 41.99 37.07 838.0 959.6 1072.2 1015.1 10.44.51 41.99 34.60 961.3 1074.0 1071.3 1.0.44.51 41.40 846.0 961.3 1077.2 1021.3 1.0.5.4 1.0.5.7 10.5.4 1.0.5.7 10.5.4 1.0.5.7 10.5.4 1.0.5.7 10.5.4 1.0.5.7 10.5.4 1.0.5.7 10.5.8 1.0.5.7 10.	8 35.90 32.79 828.2 951.3 1067.0 1012.5 37.77 34.72 833.1 959.8 1067.0 1010.4 37.77 34.72 833.1 959.8 1069.9 1016.4 41.99 38.00 959.6 1672.2 1012.1 106.4 41.99 38.00 959.6 1672.2 1012.1 10.4 44.51 41.40 846.0 968.0 1077.2 1021.3 11.48.8 45.74 853.1 975.3 1081.1 1072.7 11.2 53.12 50.19 854.2 972.5 1065.4 1024.6 13.2 53.12 50.01 855.2 983.7 1065.7 1075.8 13.5 57.45 554.35 863.3 987.1 1087.3 1031.6 13.5 6.1 74.58 554.35 863.3 987.1 1087.3 1031.6 13.5 6.1 74.58 75.58	8 35.90 32.79 828.2 951.3 1067.0 1012.5 37.77 34.72 833.1 959.8 1067.0 1010.4 37.77 34.72 833.1 959.8 1069.9 1016.4 41.99 31.92 951.3 1072.2 1012.1 106.4 41.99 31.40 846.0 961.3 1074.0 1071.3 11.40 846.0 961.3 1077.2 1021.3 11.48.84 45.74 853.1 975.3 1081.1 1072.7 11.2 53.12 50.19 854.2 975.3 1081.1 1072.7 11.2 53.12 50.10 855.2 983.7 1065.4 1075.8 11.2 53.15 863.3 981.7 1065.7 1075.8 11.8 858.6 981.6 1086.5 1031.6 11.8 61.74 562.56 55.34 864.4 986.2 1089.2 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 61.74 588.6 987.1 1087.3 1031.4 11.8 62.56 63.8 66.8 68.8 67.0 69.3 1031.4 11.8 62.56 63.8 66.8 68.8 67.0 69.3 1031.4 11.8 62.56 63.8 66.8 68.8 68.8 69.3 1090.5 1031.4 11.8 62.56 63.8 63.8 66.8 68.8 68.8 68.8 69.3 1090.5 1031.4 11.8 62.56 63.8 68.8 68.8 68.8 69.3 1090.5 1031.4 11.8 62.56 63.8 69.8 69.3 1090.5 1031.4 11.8 62.56 63.8 69.8 69.3 1090.5 1031.4 11.8 62.56 63.8 69.8 69.8 69.8 69.3 1090.5 1031.4 11.8 62.56 63.8 69.8 69.3 1090.5 1031.4 11.8 62.56 63.8 69.8 69.3 1090.5 1031.4 11.8 63.8 69.8 69.8 69.8 69.8 69.8 69.8 69.8 69			34.05	616.9	0 4 0		0.700	000		970.3	ŋ -	930.0	1 437.6 420.0	.3 930.0 920.0 922.3 1 037 £ 005 7 008 A
2 37-77 34-66 832-8 958-4 1070-1 1010-4 37-77 34-66 833-8 958-4 1070-1 1010-4 40-18 37-07 838-0 959-6 1072-2 1015-1 1 41-99 38-0 959-6 1072-2 1015-1 1 40-99 38-0 961-3 1074-0 1071-3 1 46-09 961-3 1077-2 1071-3 1 46-09 961-3 1077-2 1071-3 1 46-09 961-3 1077-2 1071-3 1 1 46-09 961-3 1081-1 1072-7 1 1 46-09 972-8 1081-1 1072-7 1 1 2 53-12 50-01 854-2 972-5 1065-7 1075-8 1 57-45 54-29 51-18 858-6 981-1 1081-3 1030-4 1 1 1 1030-4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2 37-77 34-66 832-8 958-4 1070-1 1010-4 37-77 34-66 832-8 958-4 1070-1 1010-4 40-18 37-07 838-1 959-6 1072-2 1015-1 104-9 38-90 38-0 959-6 1072-2 1015-1 100-4 40-1 41-40 846-0 961-3 1074-0 1077-2 1071-3 1046-0 967-6 1078-3 1075-4 1076-3 1081-1 1072-7 1075-4 1076-3 1081-1 1072-7 107	2 37-77 34-66 832-8 958-4 1070-1 1010-4 37-77 34-66 833-8 958-4 1070-1 1010-4 40-18 37-07 838-0 959-6 1072-2 1015-1 104-0 34-99 34-72 838-0 959-6 1072-2 1012-1 104-0 34-91 31-07-2 1077-2 1077-3 1077-2 1071-3 1075-4 1078-3 1075-4 1075-8 1075	•	35.90	32,79	828.2	951.3	1067.0	012.5	1 2 66		677.7	977.7		7 942.7	7 942.7 430.5
37,83 34,72 833,1 954,8 1069,9 1016,4 40,18 37,07 838,0 959,6 1072,2 1012,1 1 10 4,51 41,40 846,0 961,3 1074,0 1071,3 1 46,09 42,98 848,6 967,6 1078,3 1075,4 1075,4 1 50,19 47,08 854,2 972,5 1067,4 1076,6 1 1072,7 1 1072,7 1 1072,7 1 1072,7 1 1072,7 1 1072,7 1 1072,7 1 1072,4 1 1074,6 1 1074,6 1 1074,6 1 1074,6 1 1075,8 1 1 1072,4 1 1072,4 1 1072,4 1 1 1 1072,4 1 1 1 1072,7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	37.83 34.72 833.1 959.8 1069.9 1016.4 41.99 40.18 37.07 838.0 959.6 1672.2 1012.1 1 10.9.9 1016.4 41.99 38.88 840.8 961.3 1674.0 1071.3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	37.83 34.72 833.1 959.8 1069.9 1016.4 41.99 38.88 840.8 961.3 1072.2 1012.1 10 44.51 41.40 846.0 968.0 1077.2 1021.3 1 46.09 42.98 848.6 967.6 1078.3 1075.4 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 12 53.12 50.01 859.5 983.7 1085.7 1075.8 1 54.29 51.18 858.6 980.6 1086.5 1031.6 1 58.45 55.34 864.3 987.1 1087.3 1031.4 1 62.56 59.45 865.3 866.3 1090.5 1031.4 1	~	37.77	34.06	· ~	958.4	1070.1	1010.4	949.R		5xc.1		946.3	946.3 934.6	946.3 934.6 934.6
9 40.18 37.07 838.0 959.6 1072.2 1012.1 1 10 44.51 41.40 846.0 961.3 1074.0 1071.3 1 10 44.51 41.40 846.0 968.0 1077.2 1021.3 1 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 12 53.12 50.01 859.5 983.7 1085.7 1025.8 1 13 57.45 54.35 863.3 981.1 1087.3 1030.4 1	9 40.18 37.07 838.0 959.6 1072.2 1012.1 1 10 44.51 41.40 846.0 908.0 1077.2 1021.3 1 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 12 53.12 50.01 859.5 983.7 1085.7 1025.8 1 13 57.45 55.34 863.3 987.1 1087.3 1031.6 1 14 61.74 56.3 864.2 987.1 1087.3 1030.4 1 15 58.45 55.34 864.4 986.2 1089.2 1032.4 1	9 40.18 37.07 838.0 959.6 1072.2 1012.1 1 10 44.51 41.40 846.0 961.3 1074.0 1071.3 1 10 44.51 41.40 846.0 968.0 1077.2 1021.3 1 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 12 53.12 50.01 859.5 983.7 1085.7 1025.8 1 13 57.45 54.35 863.3 987.1 1087.3 1031.6 1 14 61.74 58.65 886.3 1090.5 1031.4 1 14 61.74 58.65 886.5 988.7 1087.3 1031.4 1 15 61.74 58.65 886.5 988.7 1087.3 1031.4 1 16 61.74 58.65 886.5 988.7 1080.5 1031.4 1		37.83	34,72	<u>~</u>	954.8	1009.9	1016.4	999.3		940.1		946.3	946.3 934.2	946.3 934.2 935.2
41.99 38.88 840.8 961.3 1074.0 1071.3 1 46.09 42.98 848.6 967.6 1078.3 1075.4 1 45.09 42.98 848.6 967.6 1078.3 1075.4 1 50.19 47.08 854.2 972.5 1067.4 1072.7 1 57.45 57.45 57.45 858.6 961.1 1087.3 1075.8 1 57.45 57.45 863.3 981.1 1087.3 1031.6 1 58.45 57.45 58.45 663.3 981.1 1087.3 1030.4 1 1087.3 1030.4 1	41.99 3H, 88 840.8 961.3 1074.0 1071.3 1 46.09 42.98 848.6 967.6 1078.3 1075.4 1 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1067.4 1074.6 1 54.29 51.18 858.6 981.7 1085.7 1075.8 1 57.45 55.34 863.3 987.1 1087.3 1031.6 1 58.45 55.34 864.4 986.2 1089.2 1037.4 1	41.99 3H, 88 840.8 961.3 1074.0 1071.3 1 46.09 42.98 848.6 967.6 1078.3 1075.4 1 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1067.4 1074.6 1 54.29 51.18 858.6 981.7 1085.7 1075.8 1 57.45 54.35 863.3 987.1 1087.3 1031.6 1 58.45 55.34 864.4 986.2 1089.2 1037.4 1 62.56 56.45 865.6 988.6 1090.5 1031.4 1	6	40.18	37.07	38.	9.656	1072.2	1012.1	1003.6		982.4		950.7	950.7 938.6	950.7 938.6 938.2
10 44.51 41.40 846.0 908.0 1077.2 1021.5 1 46.09 42.98 848.6 967.6 1078.3 1075.4 1 50.19 47.08 854.2 972.5 1067.4 1024.6 1 54.29 51.18 858.6 981.1 1085.7 1075.8 1 54.29 51.18 858.6 981.1 1086.5 1031.6 1 58.45 54.35 863.3 981.1 1087.3 1030.4 1	10 44.51 41.40 846.0 908.0 1077.2 1021.5 1 46.09 42.98 848.6 967.6 1078.3 1075.4 1 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1067.4 1074.6 1 54.29 51.18 858.6 981.7 1085.7 1075.8 1 57.45 55.34 863.3 987.1 1087.3 1030.4 1 58.45 55.34 864.4 986.2 1089.2 1037.4 1	10 44.51 41.40 846.0 908.0 1077.2 1021.5 1 11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 12 53.12 50.01 854.2 972.5 1067.4 1074.6 1 13 57.45 54.35 863.3 987.1 1087.3 1031.6 1 14 61.74 55.34 864.4 986.2 1089.2 1037.4 1 15 62.56 59.45 865.5 988.7 1089.2 1037.4 1		٠.	34° A8	40.	961.3	1074.0	1021.3	1004.9		6.586		953.4	953.4 941.3	953.4 941.3 940.4
46.09 42.98 848.6 967.6 1078.3 1075.4 1 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1067.4 1024.6 1 54.29 51.18 858.6 981.1 1085.7 1031.6 1 57.45 5 54.35 863.3 981.1 1087.3 1030.4 1	46.09 42.98 848.6 967.6 1078.3 1075.4 1 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1087.4 1024.6 1 54.29 51.18 858.6 987.1 1087.3 1031.6 1 58.45 55.34 864.4 986.2 1089.2 1037.4 1 4 58.45 55.34 864.4 986.2 1089.2 1037.4 1	46.09 42.98 848.6 967.6 1078.3 1075.4 1 1 48.84 45.74 853.1 975.3 1081.1 1072.7 1 1 1072.7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		'n.	41.40	46.	96H.0	1077.2	1021.5	1007.2		1.947		956.7	956.7 944.4	956.7 944.4 943.3
11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1067.4 1024.6 1 54.29 51.18 858.6 980.6 1086.5 1031.6 1 57.45 54.35 863.3 987.1 1087.3 1030.4 1	11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1062.4 1024.6 1 12 53.12 50.01 859.5 983.7 1065.8 1 54.29 51.18 858.6 980.6 1086.5 1031.6 1 13 57.45 54.35 863.3 987.1 1087.3 1030.4 1 58.45 55.34 884.4 986.2 1089.2 1030.4 1	11 48.84 45.74 853.1 975.3 1081.1 1072.7 1 50.19 47.08 854.2 972.5 1062.4 1024.6 1 12 53.12 50.01 859.5 983.7 1065.8 1 54.29 51.18 858.6 980.6 1086.5 1031.6 1 13 57.45 54.35 863.3 987.1 1087.3 1030.4 1 14 61.74 56.59.45 886.8 969.3 1090.5 1037.4 1 62.56 59.45 886.8 969.8 1090.5 1031.4 1		٥,	42.98	æ '	967.6	1078.3	1025.4	9.6001		æ.		958,7	958.7 946.7	958.7 946.7 944.5
\$0.19 47.08 854.2 972.5 1067.4 1024.6 1 12 53.12 50.01 859.5 983.7 1065.8 1 54.29 51.18 858.6 980.6 1086.5 1031.6 1 13 57.45 54.35 863.3 987.1 1087.3 1030.4 1	12 53,12 50,01 854,2 9/2,5 1067,4 1024,6 1 12 53,12 50,01 859,5 983,7 1065,8 1 54,29 51,18 858,6 980,6 1086,5 1031,6 1 13 57,45 54,35 863,3 987,1 1087,3 1030,4 1 58,45 55,34 884,4 986,2 1089,2 1030,4 1	12 53,12 50,01 854,2 9/2,5 1067,4 1024,6 1 12 53,12 50,01 859,5 983,7 1065,7 1075,8 1 54,29 51,18 858,6 980,6 1086,5 1031,6 1 13 57,45 54,35 863,3 987,1 1087,3 1030,4 1 58,45 55,34 884,4 986,2 1089,2 1037,4 1 62,56 59,45 887,7 988,6 1090,5 1031,4 1		Œ. '	45.74	853.1	975.3	1081.1	1022.7	1011.2		992.7	٠.	.7 961.8	.7 961.8 948.9	.7 961.8 948.9 947.3
12 55,12 50,01 854,5 983,7 1055,8 1 54,29 51,18 858,6 980,6 1086,5 1031,6 1 13 57,45 5 54,35 863,3 987,1 1087,1 1010,4 1 58 45 45 45 45 45 45 45 45 45 45 45 45 45	12 55,12 50,01 854,5 983,7 1055,8 1 54,29 51,18 858,6 980,6 1086,5 1031,6 1 13 57,45 54,35 863,3 987,1 1087,3 1030,4 1 58,45 55,34 884,4 986,2 1089,2 1037,4 1	12 55,12 50,01 854,5 983,7 1055,8 1 54,29 51,18 858,6 980,6 1086,5 1031,6 1 13 57,45 54,35 863,3 987,1 1087,3 1030,4 1 58,45 55,34 884,4 986,2 1089,2 1032,4 1 14 61,74 56,63 886,8 989,3 1090,5 1031,4 1	,	۳,	47.08	854.2	972.5	1062.4	1024.6	1013.2		5	_	_	.7 963.1 950.4	.7 963.1 950.4 948.4
13 57,45 54,35 863,3 987,1 1087,3 1030,4 1 58 45 54 45 54,35 863,3 987,1 1087,3 1030,4 1	54.29 51.18 858.6 480.0 1085.5 1051.6 1 53 57.45 54.35 863.3 987.1 1087.3 1030.4 1 58.45 55.34 884.4 986.2 1089.2 1032.4 1	13 57.45 54.35 863.3 987.1 1087.3 1031.6 1 58.45 55.34 864.4 986.2 1089.2 1032.4 1 14.6 61.74 56.563 866.8 866.8 969.3 1090.5 1031.4 1 62.56 59.48 867.7 988.6 1090.9 1031.4 1	~	٦,	50.03	6 C	983.7	1065.7	1025.8	1016.5		9.450	9.47	4.6. 465.6	44.6 965.6 952.8	44.6 465.6 952.8 950.3
1 01.043 34.004 40.454 40.451 1080,05 11.10.46 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	19 10.043 10.0453 805.54 400.1 10.05.54 11.10.34 1 558.45 155.34 864.4 9865.2 10.89.2 10.32.4 1 4 61.74 15.045.8 050.3 10.00.5 10.31.4 1	13 17,43 14,53 801,54 407,1 1087,5 10190,4 1 58,45 55,34 864,4 986,2 1089,2 1037,4 1 14 61,74 56,63 866,8 969,3 1090,5 1031,4 1 62,56 45 867,7 988,6 1090,9 1031,4 1	•	``	_ •	Ĭ,	フ r	20801	0.31.0	101/.3		6.566		. 967.1	9 967.1 453.9	9 967.1 453.9 951.3
	* ************************************	14 61.74 5.63 886.8 969.8 1090.5 1031.4 1 62.56 59.45 887.7 988.6 1090.9 1033.3 3	•	•	44,20	2 4	967	7 0 50 7	4 6 6 6	0.0101		7.000	•	•	2.00. 2.00.	1 040 0 047 1 043 B
62.56 59.45 867.2 988.6 1090.9 1033.3 1 15 66.07 62.97 869.3 987.7 1092.6 1036.9 1	15 66.07 62.97 869.3 987.7 1092.6 1036.9 1			۰	m	•	91.	1092.3	34.	1024.0	~	003.0	•	.0 974.4 962.	0 974.4 962.0	0 974.4 962.0 957.9 949.
15 66.07 62.97 869.3 987.7 1092.6 1036.9 1036.9 1636.9 165.66 63.55 870.2 991.5 1092.3 1034.9 1	15 66.07 62.97 869.3 987.7 1092.6 1036.9 1 66.66 63.55 870.2 991.5 1092.3 1034.9 1	66.66 63.55 870.2 991.5 1092.3 1034.9 1024		7.7	•		90.	1091,7	4	1024.4		1003.1		1 975.2 962.	1 975.2 962.7	1 975.2 962.7 958.3 949.
15 66.07 62.97 869.3 987.7 1092.9 1033.3 1 66.66 63.55 870.2 991.5 1092.3 1034.9 1 8 67.77 64.67 870.7 990.4 1091.7 1041.3 1	15 66.07 62.97 869.3 987.7 1092.6 1036.9 1 66.66 63.55 870.2 991.5 1092.3 1034.9 1 3 67.77 64.67 870.7 990.4 1091.7 1041.3 1	66.66 63.55 870.2 991.5 1092.3 1034.9 1024 3 67.77 64.67 870.7 990.4 1091.7 1041.3 1024	-	0.3		•	95.	1094.1	44	1026.2			•	.0 975.9 964	0 975.9 964.0	0 975.9 964.0 959.5 951.
15 66.66 63.55 870.2 988.6 1090.9 1033.3 1 66.66 63.55 870.2 991.5 1092.3 1034.9 1 8 67.77 64.67 873.7 990.4 1091.7 1041.3 1 16 70.35 67.24 873.7 995.3 1094.1 1044.5 1	15 66.07 62.97 869.3 987.7 1092.6 1036.9 1 66.66 63.55 870.2 991.5 1092.3 1034.9 1 3 67.77 64.67 870.7 990.4 1091.7 1041.3 1 16 70.35 67.24 873.7 995.3 1094.1 1044.5 1	66.66 63.55 870.2 991.5 1092.3 1034.9 1024 3 67.77 64.67 870.7 990.4 1091.7 1041.3 1024 16 70.35 67.24 873.7 995.3 1094.1 1044.5 1026	•	.,	6,	73.	94.	•	36.	1025.7		3	3.2 976	3.2 976.3 963.	3.2 976.3 963.8	3.2 976.3 963.8 959.6 951
15 66.07 62.97 869.3 987.7 1092.6 1036.9 1036.9 1633.3 1 66.66 63.55 870.2 991.5 1092.8 1034.9 1 870.7 990.4 1091.7 1041.3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	15 66.07 62.97 869.3 987.7 1092.6 1036.9 1 66.66 63.55 870.2 991.5 1092.3 1034.9 1 3 67.77 64.67 873.7 990.4 1091.7 1041.3 1 16 70.35 67.24 873.7 995.3 1094.1 1044.5 1 70.76 67.25 873.0 994.7 1093.5 1036.7 1	66.66 63.55 870.2 991.5 1092.3 1034.9 1024 3 67.77 64.67 870.7 990.4 1091.7 1041.3 1024 16 70.35 67.24 873.7 995.3 1094.1 1044.5 1025 70.76 67.65 873.0 994.7 1093.5 1036.7 1025	11	74.08	BC . 1/	E. 9/B	A	1044.8	1.010.	1027.3		1003.6	03.6	03.6	03.6 976.8 965.0	03.6 976.8 965.0 959.8 952.

Sample 4. Thermocouple and Camera Data - Thermal Calibration

pozozoza na soszaza na kozozozona na popozozozana propozozoza na soszoza na soszoza na soszozo na soszozoza na

¥.

DATE COMPUTED . AUG-83 TIME COMPUTED 06:17:37 DATE RECORDED 11-AUG-83 TIME RECORDED 9: 6:11 PROJECT NUMBER V--C-3E

SAMPLE		CONF	⋖	ALPHA ANGLE		WEDGE ANG	N	POD AN	GLE	TIMER	۵	TIMECL		TIMEEXP
TH CALIB	_	2000		050 9.91		0°00		0 9 9 9	•	ກະດ 6.58		553 5.53		55C 94.12
RUN	- 6	7	1	ພູ	2	۵	F 8	o i	>	Z.		2		:
36	, 	19.9	1315.0	3,135+05	3.92	1.398E-01	5.1	PSF 215.92	F1/SEC 4092.1	LBM/FT3 8.297E-04		LBF-SEC/FT2 3.368E-07	· FLANGE/PIN 0.50	E/PIN 50
CAMERA	PIC	TIME	TIMEEXP	15 1		15 3	TS 4	TS S	15 6	TS 7	15 8	15.9	1510	1511
	5 0	SEC	SEC	1 930	ها	DEG F	0EG F	DEG F	DEG F	DEG F	DEG	DEG	DEG F	DEG F
		74.86	71.75	875.4	m	1093.7	1044.6	1026.4	1004.7	977.1	965.1	960.2	952.9	909.3
		78.96	75.85	877.8	-	1096.7	1040.6	1028,9	1005.9	7.616	966.9	962.4	954.5	911.0
Æ T.	=	79.02	75.91	878.7	•	1097.1	1045.9	1029.5	1006.7	979.3	967.2	962,3	954.4	911.5
		83°06	79.95	680.0	8	1098.0	1048.8	1030.3	1008.0	981.2	0.696	963,8	955.7	913.4
æ	2	83°30	80.19	880.6	~	1098.5	1047.0	1030.2	1008.0	981.3	968.7	963.4	956.5	914.1
		87.16	84.05	882.6	S	1099.8	1043.9	1031.6	1009.4	982.5	910.6	965.4	957.8	915.0
E	20	87.63	84,52	882.7	0	1100.2	1050.3	1032,5	1009.3	982.5	970.4	965.5	958,3	915.5
		91.26	88,15	884.0	~	1099.8	1046.2	1033.R	1011.1	983.7	971.9	966.7	958.6	916.5
«	21	91.91	88 88 88	884.1	0	1100.R	1052,7	1033.8	1010.5	983.9	971.8	8,996	959.3	917.4
		95.37	92.26	885.6	~	1100.7	1046.5	1035.7	1011.1	985.3	972.7	967.6	929.6	917.4
~	22	96.25	93.14	886.3	-	1101.5	1047.3	1035,5	1012.5	985.5	973.4	0.896	9.096	916.3
		•	94,12	HODEL HAS LEFT		ENTERLINE		,		•		•	•	•

Continued Sample 4.

Ħ	i ,	を できる				\$\ \ !
ARVIN	I/CALSP	ARVIN/CALSPAN .ELD SERVICES, INC.	SERVICE	ES, INC.		
YON	ARMAN (ARMAN	GAS DYNA!	IICS FA	CILITY		
ARNOL	D AIR	ARNOLD AIR FORCE STATION, TENNESSEE	17104,	FENNESSE	ند	
HASA	'RI OMS	NASA/RI 048 POD AFRSI				
PACE 4	•	٠				

Control of the second

DATE COMPUTED 3 UG-83 TIME COMPUTED 08:17:37 DATE RECORDED 11-AUG-83 TIME RECORDED 9: 6:11 PROJECT NUMBER V--C-3E

Sample	Ü	CONF	ALPHA ANGLE		WEDGE ANGLE	n	POD ANGLE	ม	TIMERD	6	TIMECL	TIMEEXP
TH CALIB		2000	9.91		60.0		9 .		6.58			94.12
RUN	Ed d	11	æ (×	۵.	- C	0	>	RHO		n x	
36	19.6	1315.0	3.136+05	3.92	1.398E-01	15.1	215.92	4092.1	8.297E-04		3.368E-07	CLANGE/FIN 0.50
CAMERA	PICT	TIME TIMEEXP	P TS12	1513	1514	1515	1516	T.	TPTI	TPT2		
	v		DEC		DEG F	DEG F	DEG	DEG F	DEG F	DEC		
	•	00.	•	•				108.0		85.0		
	₹	.02		174.3				106.0		85.0	•	
H	S			191.1				108.0		65°0	•	
SHC	_		331.	•				108.0		85.0		
;	20 (=;	352	344.9				108.0		85.0		
1	96	90.	456	4.04				0.801		85.0		
	7	20.	440	•				0.801		0.00		
¥	•	[-	9.709				0.701		0.00		
5	D q	0.51 13.0	200	1049				907		200		
4	•	•	, c	993.9						0.00		
a	22	٠٠	764	746.8				90		9 0	•	
:	25	22.4	787	768.5				108.0		9 2		
41	6 27	27,28 24,17	198	779.5				106.0		85.0		
	29	2	810.	792,6				0.801		85.0		
۲ ۲	7 31	28,4	20	199.8				106.0		85.0		
52	33	30.6	. 826.	808.3			•	108.0		85.0		
Z.		32.7	. 833.	•				108.0		85.0		
SHG	2 37	34.6	838	820.5				108.0		85.0		
•		K	838	820.6				108.0		85.0		
&	40.1	37.0	8 4 4	R25.7				108.0		H5.0		
•	7	EE 66.	847	829.3				108.0		85.0	-	
E	•	.51 41.40	- C - C - C - C - C - C - C - C - C - C	H33.7				0.901		0.58		
4		7.	900					0.00		200		
£	r	47.0		E 2				0 7 7		0 4		
Z Z	12 53	12 50	861.					108.0		95.0		
•		51	862	4	-			0. AUI		85.0		
IR	13 57	.45 54.3	865.	4				108.0		85.0		
	58	.45 55		850.7				108.0		85.0		
~	14 61	.74 58.6	869.					108.0		96.0		
,		S.	698	2				108.0		86.0		
&	15 66	07 62.9	872.	56	•			108.0		86.0		
		63.5	.	57				108.0		96.0		•
SHO	•	.17 64.6	872.	26				0.801		66.0		
H ,	_ (,35 67.2	873	8				108.0	,	3.08		
•	9,7	.16 67	4/8	829.2				0.801		98		
£	•			5				•		•		•

Sample 4. Continued

spiedeskankerezeaaan baseperaa assesessaa parakkaaa maskaren bisabereaa irakeezeko karakeeaao perakeean peel

AEDC DIVISION YOU KARNAN GAS DYNAM! ARNULO AIR FORCE STAT MASA/R! ONS PUD AFRS!	SION N GAS N FORC	DYNAMIC E STATI	AREC DIVISION TO STATION, TENNESSEE MASA/RI ONS PUD AFRSI PAGE 5	. 58 . 38 . 3								TATE CONTRACT TARE CONTRACT TARE RECORDED TO THE RECORDED TO THE RECORDED TO THE TERM TO T	DATE COMPUTED
SAMPLE		CONF	₹	ALPHA ANGLE		WEDGE ANGLE	No.	PDD ANGLE	i i	TIMERD	_	TIMECL	TIMEEXP
TH CALIB		2000		9.91		00°0		- 1 C		238 • \$8		ຣຄດ ຮູ້ອີງ	SEC 94.12
RUN	- 8		TT DEG F	FT=1	×	P PS1A	0 7 8 8	3 6) X X X 4 4	RHO LAM/FT3		#0 #0 #0 #0 #0	NIO SUNTIL
*	57	19.9	1315.0	3,13E+05	3.92	1,398E-01	-5.1	215.92	4092.1	8.297E-04		3.368E-07	05.0
CAKERA	PIC	TIME	TIMEEXP	TS12	TS13	T514	1815	1516	d.	TPT1	TPT2		
	20	SEC	SEC	DEC	DEG F	DEG F	DEG F	DEG F	DEG F	0EG F	DEG		
		74.86	71.75	876.3	861.1				108.0		86.0	•	
		78.96	75.85	878.2	863.7				108.0		86.0	•	
=	3	79.02	75.91	878.2	864.5				108.0		96.0	•	
		83.06	79.95	880.0	865.1				0.801		96.0		
æ	19	83,30	80.19	880.3	865.8				108.0		86.0		
		87.16	84.05	881.4	867.5				108.0		86.0	٠	•
4	20	87.63	84.52	882.2	867.5				108.0		96.0		
		91.26	88.15	883.6	869.3				108.0		86.0		
æ H	21	91.91	88.81	863.8	8698				108.0		96.0		
		95.37	92.26	885.2	870.6				108.0		86.0		•
æ	22	96.25	93,14	885.4	871.5				108.0		86.0	•	
		•	94.12	MODEL HAS	LEFT	CENTERLINE			٠			•	
				•									

::

1UC-83

DATE COMPUTED

.

7.

· 多人。在2000年7日

IELD SERVICES, INC.

ARVIN/CALSPA. AEDC DIVISION

Concluded Sample 4.

90 MIN

A STATE OF THE STA

INC.		7	SSEE		
AVIN/CALSPAN FIELD SERVICES, INC.		ON KARNAN GAS DYRANICS FACILITY	ROOLD AIR FORCE STATION, TENHESSEE		
SERVI		ICS F	T10%,	_	
18:00		DYKAN	E STA	ASA/HI OFS POD AFFSI	
PAR F	101	GAS	FORC	S Pun	
CALS	EDC UIVISION	ARAKK	UAIR	20 27	~
RV IB		X NO	FOL	ASA/	PAGE 2

DATE COMPUTED 16-AUG-83 TIME COMPUTED 14:14:45 DATE RECURDED 11-AUG-83 TIME RECURDED 11: 5:18 PROJECT NUMBER V--C-3E

7

7.57

1

SAMPLE		CONF	7	ALPHA ANGLE		WEDGE ANGLE	er.	POU ANG	37	TIMERD	TIMECL	TIMEEXP
		3000		9.62		90.0		3.8. 3.8.		6.59 6.59	5.56 5.56	109.08
	- V	P.T PS1A	rt Deg F	a R 1 • T	=	9 6 2 7 8		3 % 0) } }	RHO	0.4 0.4 0.50	10/3/2013
	2		978.0	4,41E+05		1.450E-01	98.0	224.45	3652.7	1.082E-03	2.786E-07	05.0
	PIC	TIME	fleesxp	TS 1	15 2	TS 3	ą.	TPT	TPT2			
	¥0.		SEC	DEG F			DEG F	DEG F	DEC			
		0000		94.7			0.80		84.0		•	
		4.02		94.6			0.80		0.48			
	~	5.32		Ø . 10			0.00		2 0			

Į	EEXP	TS 1	TS 2	TS 3	16	TPT1	TPT2	
•	SEC	DEG F	DEC F	DEG F	050	DEG P	55.5	
		94.7	97.7		0.80	•	94.0	
		94.6	97.6		0.86		0.48	
		8.76	98.0		0.86) · *	
	4.66	90.5	88.7		0.H6		0.48	
٠	2.00	91.5	94.7		0.80		0.48	
	6.51	0.10	H9.7		0.86		84.0	
	9.01	91.2	90.5		9 H • 0		64.0	
	10.75	91.5	92.9		98.0		# C. C	
	3.0	89.4	98.0	•	9H.0		95.0	
	15.09	87.4	86.4		0.86		85.0	
	0.	.69.3	9.68		3.0		65.0	
	9,3	9.0°C	86.5		0.80		85.0	
-	3.0	90.5	6.06		0.86		85.0	
•	3.7	87.5	87.9		0.86		85.0	
	7.10	6.00	£ .		30		85.0	
	6.7	0.06	94.0		0.86		85.0	
	1.2	87.1	6.06		98.0		85.0	
	2.3	47.9	86.9		0.86		95.0	
	4.5	8.06	4. 06		98.0		85.0	
	5.	P 8 . 2	86.8		0.86		85.0	
	30.05	A1.6	85.9		98.0		65.0	
	₹.	91.7	90.7		0.86		85.0	
	••	84.2	91.4		0.86		H5.0	
	3.5	41.3	91.3		0.86		85.0	
	45.27	87.7	85.3		0.86		85.0	
	7.6	# B . S	88.2		0.86		85.0	
	49.55	88.7	87.6		0.86		85.0	
	1.7	89.7	87.4		0 H 6		H5.0	
	3.4	90.6	8.68		0° ¥6		45.0	
	55,82	91.0	6.8		O. 40		85.C	
		87.6	H9.1		3.86		95.0	
	4.6	91.4	69.5	•	0.86		0.68	
	2.5	RH . 4	86.1		0.86		0.58	
	64.UR	6.78	91.1		0.86		85.0	,
	٠	6.68	84.7		96		85.0	
	Ŧ.	91.1	88.8		98.0		85.0	
	68.19	6.06	87.4		0.86		H5.0	
	•	87.1	5.0				C'SI	

Material Evaluation Thermocouple and Camera Data -Sample 5.

Opensional regions of proposity Kanasawa (basedata) Regional (basedies) (basedies) (basedies) (d

AKVIM/CALSPAM FIELD SERVICES, INC. AEDC DIVISION VON KARMAN GAS DYNAMICS FACILITY ARROLD AIR FOPCE STATION, TENNESSKE NASA/41 OMS PUD AFPSI PAGE 3

DATE COMPUTED 16-AUG-83 TIME COMPUTED 14:14:46 UATE RECOMDED 11-AUG-83 TIME RECOMDED 11: 5:18 PROJECT NUMBER V--C-3E

3

公

•••

SH.

Ċ,

SAMPLE		CUNF	AL	ALPHA ANGLE		WEDGE ANGLE	M	POU ANG	3	TIMERO	TIMECL	TIMEEXP
ia.		3000		9.92		90.0) • • • •		0.59 6.59	5.56	109.08
AU W	- ă	PT	1.1	Rr. F.T.	×	9 9	# UNIO	و د د	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	RHO THM 75T3	0 t 3 / J 3 S = 5 G 7	AT OVER THE
30	. ~	20.2	978.0 4	4.41E+05	3.92	1.450E-01	0.86	224.45	3652.7	1.082E-03	2.786E-07	05.0
CAMERA	PIC	TIME	TIMEEXP	TS 1	TS 2	TS 3	4	TPT1	TPT2			
	0	SEC	SEC	DEG F	DEG F	DEG F	DEG F	DEG F	0EG F			
		75.40	72.29	63°8	93,3		0.86		85.0		•	
11	8	78.57	75.45	88.3	90.5		0.86		85.0			
	-	79.52	76.40	87.5	85.8		0.86		H5.0			
IR	19	82.86	14.74	91.9	93.0		0.86		85.0			
		H3.62	80°28	8 H 9	86.48		0.86		45.0			
4	20	87.19	84.07	92.5	90.5		0.86		85.0			
		87.72	84.00	90.2	1.0E		C. Ho		95.0			
4	21	71.47	RH. 35	89.6	40.7		0.86		H5.0			
		91.12	8H.70	91.1	88°5		0 H 6		45.0			
¥ 45	22	95.RO	92.68	91.5	89.5		98,0		85.0		•	
		95.92	92.80	.02.1	91.6		0.86		45.0			
SHC	•	47.14	94.62	92.3	89.1		0.86		85.0			
		100.02	96.96	94.2	91.4		0.86		85.0			
I R	33	100.14	97.02	94.7	92.4		0.86		0.58			
		104,18	101.06.	90°4	86.8		0.86		30.0			
IR R	7	104,42	101,30	906	91.4		0.86		85.0			
		104,28	105.16	90.5	87.9		0.86		95.0			
a a	52	108,75	105.63	94.8	8008		0.86		95.0			
			109.08	MUDEL HAS	LEFT	CENTERLINE						

DATE RECORDED
TIME RECORDED
TIME COMPUTED
PHOUSET NO V C

MU LRF-SEC/+T2 1.528E-07

		RHO LBM/FT3 3.075K-03
		V FT/SEC 2055.
		3 m 3 m 3 m 5 m
		T DEG F -269.7
		P PS1A 2.171E-01
		H .9.
_	POD ANGLE PEG 0.00	RE FT=1 1.67E+06
RI OMS POD	WEDGE ANGLE Dec -0.05	77 DEG F 315.0
	0 0	PT PSIA 30.0
I OHS PO	ALPHA Deg 10.05	1000
2 5		

	PHS PSIA		0.3988	206	ē	-	3	4	ੌਂ.	.24	51	54	. 4 E	174	0	
*																
Pressure	2 z	•	♂ ≃		٠.			3.86	6.		3	.2	æ	6	5.88	
SUHFACE	× ×	•	6,25		•			•			•			00.0		
SEC ***	×Z	•	17.42	4.	٠,	4.9	6.4	17.42	ີ.	6.4	€.	17.78	æ.	•	2	
	KULITE NO.	101	103	104	105	106	107	108	110	112		116			125	

163. 163. 165.

90

1112.

66

Sample 6. RMS Pressure Data - Pressure Calibration

I SC	LITY	2	
Services.	S FACII	ION, TE	
N ELD SERVICES, INC.	YON KARMAN GAS DYNAMICS FACILITY	ARKOLD AIR FORCE STATION, TENN	•
ICSPAN ISTON	AAN GAS	IIR FOR	ONS PU
ARTHICAGSPAN	TON KAR	LRKOLD ,	NASA/RI OMS PUD

1.000.000

THE PARTY OF THE PROPERTY OF T

Ċ

H

15-SEP-44

5-AUG-H1191 JU 12:411 44 C-36

DATE COMPUTED DATE COMPUTED TIME MECONDED TIME COMPUTED PROJECT NO V C

	>	FSIA DEG F FSF FT/SEC LBM/FT3 1.171E-01 -269.7 338.0 2655. 3.075E-03	
31	x	3.93	ø
POD ANGLE DEG 0.00		1.67E+06	CENTER LINE 5. SECS
WEDGE ANGLE DEG -0.05		315.0	NTER LINE
) i	74	30.0	ROM CEN
AL.PHA DEG 10.05	CONF	1000	TIME FROM
	30	~	

AU LHt-SEC/FT2 1.528E-07

*** SURFACE PRESSURE DATA ***

a. U	0.23				•	•	0.25		•	•	•	67.0			•					1.22			•	•	•	•	•	•	0.34	•	•	•	C 7
PW-PIN PSIA	0.558		``	٠,	2	æ.	S,	₹.	0.572	۲,	ť.	3	۶.	S	ĉ.	4	٤	٥.	٠,	Ŧ.	٠.	ુ.	æ		٣,	ع.	ç.	Ē.	æ	٦.	4.	E	C.
PW/PIN	3.57	30° 50° 50° 50° 50° 50° 50° 50° 50° 50° 5	4.26	3,55	3.60	3.59	3.68	3.67	3.63	3.63	3.60	3.59	3,55	3.61	3.58	3.91	4.14	5.40	C	14.10	5.57	10.07	5.02	4.65	11,63	3,82	3.80	4.12	4.85	6.17	7.70	9.41	10.42
PW	0.775	0,755		•	•	•	•	•	•	•	•	•		•			•	•		•		•	•	•	•	•	•	•	•	•	•	•	•
z n z	00.00	• •	?		•	Ċ	=		•	•	•		•		•	•	•		•			2.40	•	•	•	•	•	•	•	•	•		•
Z H	2.50	•	. 2	7	?	~	~	~	~	7	~	7	7	2.5	7	~	7	٦,	۲.	3	s.	S.	S.	ຮຸ	ď,		۲,	7	۲,	ď	4	7	۲,
×z	10.50	, e	`	•	•	ċ		_:	- :	?	~	÷	÷.	4.	4	š	Š.	•	۲.	æ	•	•	ċ	Ġ	œ	š	'n	ŏ	•	ė	۲.	ř	
STATIC	-0	~ ∢		•	_	ac	٥	2	=	12	13	+ :	15	16	17	19	19	101	102	103	104	105	106	101	108	100	110	111	112	113	114	115	116

67

Static Pressure Data - Pressure Calibration Sample 7.

possition separate appropriate appropriate processes acceptant acceptant

*

-;

10 XX XX

THE STANSACTION OF THE STANSACTI

	RHO	LBM/FT3
		2655. 3
	e	33A.C
	+ i	-269.7
	۵.	2.171E-01
	×	3.93
POD ANGLE DEG 0.00	8 3 6 4	1.67E+06
WEDGE ANGLE DEG -0.05	11 2	315.0
460	P	30.0
ALPHA Deg 10.05	CONF	1000
-	RUM	~

MU LBF-SEC/FT2 1.528E-07

*** SURFACE PRESSURE DATA ***

STATIC NO	×z	# H	N N	PW	PW/PIN	PK-PIN PSJA	ື້	
117	18,16	0.25	3.56	2,396	11,03	2,179	6,43	
118	18.46	0.25	3.86	2,497	11,50	2,280	74.0	
119	18,97	0.25	4.15	2,516	11,59	2,299	*5.0	
120	19,39	0.25	4.43	2,450	11.28	2,233	56.0	
121	19.81	0.25	4.69	2,336	10.76	2,119	05.0	
122	20.24	0.25	4.95	2,285	10,52	2,007	× 20	
123	20.68	0.25	5.19	2,135	9.B3	1,918	0.62	
124	21.12	0.25	5.43	2.044	9.41	1,827	#/ °0	
125	22.01	0.25	5.88	1.917	8.83	1.700	27.0	
126	16,45	-2.50	1.75	1,051	4.84	0. ×33	0.35	
127	18.56	-2.50	3.86	2.214	10.19	1,996	0.85	
128	16.45	-4.50	1.75	1,065	16.1	E # 0	45.3	
129	14,56	-4.50	3.86	2,702	12,45	2,465	40.7	
130	16,45	-5.50	1.75	1,155	5,32	854.0	27.3	
131	10.45	-6.50	1.75	1,290	5.94	1,0/3	27.0	
132	18,56	-6.50	3.86	3.012	16.04	3,395	1.45	

Sample 7. Concluded

当は

5-SEP-"

DATE COMPUTED

3

11-AUG 9: 6: 13 12:38: 22

DATE RECORDED
TINE RECORDED
TIME COMPUTED
PROJECT NO V C

C-3E

	ALPHA DEG Y.91	3 0	WEDGE ANGLE Deg 0.09	POD ANGLE DEG -8.00						
RUK		T	LI	ж :	x	a .	; ₽- 1	c	>	KHO
5 6	2000	19.9	19.9 1314.0	3.136+05	3.92	1.397E-01	2 4 . S	215.9	+ T/SEC 4091.	E8.272E-04
	TIME F	FROM CEN	TER LINE	DM CENTER LINE 20. SECS						

MU LHF-SEC/FT2 3.300E-U/

*** SURFACE PRESSURE DATA ***

STATIC	× 2	⊁ H	z z	PW	PW/PIN	PN-PIN PSIA	ភ្ជ
_	10.50	2,50	00.0	824	10 1	G	50.0
) (* * * * * * * * * * * * * * * * * * *	
•	20071	1.0.7	-	74701	# I * 7 C	5.1.	7.5
~	13.50	2,50	0000	0.543	9. F.G	404.0	0.27
•	14.50	2.50	00.00	0.555	3.97	0.410	0.28
In	15,25	2.50	0.00	0.549	4.22	244.0	0.30
£	7.00	6.25	00.0	0.176	1.24	0.036	20.0
7	8.00	0.25	00.0	0.204	1.45	\$40°0 .	40.0
Œ	00.6	0.25	00.0	0.278	00.	0.138	00.0
o	10.00	0.25	00.0	0,391	2.80	0,252	0.17
01	11,00	0.25	00.0	0.475	3.40	0.336	0.42
11	11,50	0.25	00.0	0,493	3.53	0,353	0.24
12	12.00	0.25	00.0	0,514	3.68	0,375	0.45
13	12,50	0.25	00.0	0.514	3.68	0.3/4	0.25
14	13.00	0.25	00.0	0.528	3.78	0,389	0.26
15	13,50	0.25	0.00	10,762	77.05	10,622	7.09
16	14,25	0.25	00.0	0.543	3.49	0,403	0.27
17	14.50	.0.25	00.0	0.565	4.04	0.425	67.0
18	15.00	0.25	00.0	0.582	4.16	0.442	67.0
0	15.25	0.25	00.0	0.627	4.49	0.48A	0.43

Sample 8. Static Pressure Data -Thermal Calibration and

Material Evaluation

69

į

A V V V V V V V V V V V V V V V V V V V	AEDC DIV. ARVIN/CALS VUN KARHAN ARNOLD AIR NASA/RI ON PROJECT V4	ARDC DIV. ON ARVIN/CALSPAN FIELD VUN KARMAN GAS DYNA, ARNOLD AIR FORCE ST NASA/RI ONS POD AFR, PROJECT V4 C-3E	ARDC DIV. ON ANVIN/CALSPAN FIELD SI VUN KARMAN GAS DYNAMI ARNOLD AIR FORCE STAT MASA/RI ONS POD AFRSI PROJECT V4 C-3E	ERVICES CS FAC 10N, T	IELD SERVICES, INC. DYNAMICS FACILITY (VKF) E STATION, TENNESSEE AFRSI TEST			■ ③		Ė				- - 		DATE TIME TIME	COMPUTED COMPUTED RECORDED		12-5cP-#3 13:01 11-AUG-83 9: 6:		
8 A M	SAMPLE		CONF		ALPHA		WEDGE A	ANGLE	P 00	POD ANGLE		714	TIMEING		TIMECL	CI.					
TH CALIB	LIB	MATL	, EVAL PHASE	HASE	9.91		0.0	60	. 8.00	00		8.54 5.54	•	X &	MIN SEC 6 22	22 967					
RUN 26		PSIA 19.9	TT DEG F 1314.0	. •••	RE FT-1 1.12E+05		2	PS1A 1.397E-01	DEG 1	L 4	e PSF 215.9	V FT/SEC 4091.	~	RHU 1.8M/FT3 1.272E-04		hU LHF—SEC/FT2 3.306E-07	/FT2 -07		-		
	MODE	HÖDEL EHISSIVITY	IVITY	0.82																	
		č	2 2 2	¥			ä	TEMPEKATURE TIME EXP 6		ECORD 249	SEC TH	•					•				
		•		2		-		*	*** POINT	*											
2117	•	•	` •	•	•	. •	10	==	2	13	Z	5	•	11	æ	0	20	23	22	23	
33	332	~	M	335.	335.	335.	338.	343,	343.				370.	410.	4H2.	540	609	. 849	725.	778.	
*	326	326	329	329	335	338	46	338	346		351.	351.	363.	5	472			663.	720.	773.	
3 %	317) ~	317	326	326.	329.	332.	335.				, 20 E	415	4H3.		611.	672.	727.	780.	
37	320	320	317	323.	326.	323.	320.	335	335	340.	\$ 5	351.	305.	417.	48.			675.	732.	783.	
£ 6	314			314.	317.	320.	323.	326.	332.	38.		346.	372.	437.	506.		632.	6 × 9.	743.	790	
? ?	314	311	317	314.	314.	317.	320.	323.	323.	329.	32.		372.	4 54.	506.			685.	740.	788	
. 2		• •		314.	317.	314	332.	320.	332.	332.			422.					733.	7.79	# 1 R .	
? ‡	311	•		304.	311.	317	317.	320.	326. 320.				427.	500.	506.	623.	3 X C	731.	7.18.	818.	
\$	308	PO F	301	311.	311	314	311.	320	314		338		372.	67.6					757.	743.	
+ +	30.8			308	308	314.	317.	323. 323.	326.				376. 376.	440 440	510. 512.			643.	/42.	TO 10	
4 4	308	308	311	308	320.	314	317.	320.	320.				572.	437.	503			645.	738.	765.	
20	71			314	317	314	326	329	323.				308.	417.	457			66%	724.	772.	
25 25	320	m m		323.	320.	326. 326.	326.	323. 324.	326. 335.		363. 363.	351. 351.	370°	412.	4×3.	544.	2 c	668. 540.	723.	774.	
5 3 5 4	320	320		329	329.	329	329	338.	33%			361.	574°	476.				69H.	760.	#10.	
5	-	337	335	334	329	338	338.	348	351.			370.	593.	E 7	521.			747.	b12.	671.	
5 6	~	338	340	335	340	343.	346	348	35.3 25.6				395.	442.	515.			751.	821.		
	340	338	7	4	338	348	2	353.	958			376.	347.	431.	505	F.7 .		742.	0 1 1 °	H 7 3.	
6 9 6 9	-	346	346	351.	346	353	356.	358	9 4	361.	368		391°		502	•	603.	7 35.	8 C W	# 0 N .	
61	· •	356	351.	8	351.	353.	353.	358.	358	365.	2	3 H J .	345	4 32.	505	, tr	hb 1.	7.32.	794.	5	

*** *** *** *** *** ***

938 -

REPRESENTATION OF THE PROPERTY OF THE PROPERTY

Sample 9. Infrared Data - Thermal Calibration and Material Evaluation

O

O